California Air Resources Board

Greenhouse Gas Quantification Methodology for the Strategic Growth Council Affordable Housing and Sustainable Communities Program

Greenhouse Gas Reduction Fund
Fiscal Year 2015-16

Version 2
March 23, 2016

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Section A. Introduction

The California Air Resources Board (ARB) is responsible for providing the quantification methodology to estimate greenhouse gas (GHG) emission reductions from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF) for California Climate Investments. For the Strategic Growth Council's (SGC) Affordable Housing and Sustainable Communities (AHSC) Program, ARB staff developed this GHG emission reduction quantification methodology to be used by applicants to estimate proposed project GHG emission reductions in Fiscal Year (FY) 2015-16 and to note ongoing reporting requirements for funded projects.

This methodology uses currently available tools to estimate the change in vehicle miles traveled (VMT) and associated GHG emission reductions based on specific land use and transportation characteristics of the proposed project. These tools consist of components of the "California Emissions Estimator Model" (CalEEMod) and calculation methodologies based on the "Methods to Find the Cost-Effectiveness of Funding Air Quality Projects for Evaluating Motor Vehicle Registration Fee Projects and Congestion Mitigation and Air Quality Improvement Projects" (CMAQ Methods).

Methodology Development

ARB and SGC staff followed a set of principles to guide the development of the quantification methodology. These principles ensure that the methodology for AHSC projects would:

- Apply at the project-level.
- Align with the project types proposed for funding with the AHSC Program.
- Provide uniform methods to be applied statewide, and be accessible by all applicants.
- Estimate GHG emission reductions from a discrete list of VMT reduction measures.
- Use existing and proven tools or methodologies where available.
- Reflect relationships between VMT and GHG reductions that are supported by empirical literature.

In addition, SGC held two public "Lessons Learned" workshops in July 2015 to discuss issues faced by applicants in the FY 2014-15 AHSC application and selection process. ARB attended the workshops to listen to issues specific to the quantification methodology. The input from applicants at the Lessons Learned workshops helped to inform the updates in this quantification methodology.

ARB released a draft FY 2015-16 quantification methodology for public comment in October 2015. Public comments and changes to the Draft AHSC Guidelines were considered in the development of the December 2015 version of the Quantification Methodology.

Tools

CalEEMod and the CMAQ Methods are used statewide, are publicly available, and are subject to regular updates to incorporate new information. The tools and documentation are free of charge and available to anyone with internet access. Both methods require land use characteristics and VMT reduction features from the proposed project, which should be readily available in the project application.

CalEEMod is a "state-of-the-practice" land use emissions calculator tool designed to quantify GHG emissions and criteria air pollutants associated with land use development projects, including transit-oriented developments and mixed-used developments. CalEEMod is used statewide by lead agencies to evaluate the GHG emissions and criteria air pollutants of land use development projects pursuant to the California Environmental Quality Act (CEQA), the National Environmental Protection Act (NEPA), and for compliance with local air quality rules and regulations. CalEEMod includes a suite of mitigation measures so that a user may compare a mitigated project's emissions to an unmitigated project's emissions. The GHG emission reduction impacts of the mitigation measures were developed by and are detailed in a study conducted by the California Air Pollution Control Officers Association (CAPCOA) titled "Quantifying Greenhouse Gas Mitigation Measures" (CAPCOA Quantification Report).[1] The CAPCOA Quantification Report includes detailed fact sheets that describe the underlying research and the data used to develop the reduction impacts (also called effects or elasticities) and provide project level examples for each measure. The CalEEMod tool, User's Guide, and other supporting documents can be downloaded from www.caleemod.com.

The CMAQ Methods are a set of equations for evaluating the cost-effectiveness of certain types of transportation projects, including bicycle paths, vanpools, and new bus service. The CMAQ Methods were developed by ARB and the California Department of Transportation and are used statewide by transportation agencies to evaluate criteria pollutant emission reductions from transportation projects competing for State motor vehicle fee and federal CMAQ funding. The CMAQ Methods were used as the basis for developing the GHG reduction estimates for certain project features that are not captured in CalEEMod, specifically transit and connectivity (TAC) features. The CMAQ Methods document can be downloaded from http://www.arb.ca.gov/. However, all of the equations and assumptions needed for this quantification method are included in this document and some assumptions have been modified as necessary. Therefore, the equations used in this quantification methodology are referred to as TAC Methods.

[1] http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf

Major Updates

ARB updated the FY 2014-15 quantification methodology to enhance the analysis and provide additional clarity to project applicants. The major changes include:

- GHG emission factors that include upstream GHG emission sources. This "Well-to-Wheels" approach quantifies the emissions produced from the production; distribution of the different fuel types, including hydrogen and electricity; and any associated exhaust emissions. This approach is consistent with other GGRF programs and ARB's Low Carbon Fuel Standard (LCFS) Program.
- Equations for calculating LUT-9 and SDT-2 in the "Additional Benefits" section of this quantification methodology (instead of CalEEMod; see Table 3 for additional details).
- Clarification of how applicants should choose "Project Setting" for a project using CalEEMod.
- Clarification of the maximum percent VMT reduction possible for individual VMT reduction strategies and by Project Setting (i.e., VMT reduction "caps"). These caps are built into CalEEMod and reflect the result of literature reviewed by CAPCOA in the CAPCOA Quantification Report.
- TAC Methods to calculate new train service and new ferry service.
- Information from the approved Funding Guidelines for Agencies Administering California Climate Investments (Funding Guidelines) on reporting after a project is selected for funding. Refer to Section E for details.
- Additional definitions and clarity to the text.
- Development of an online mapping tool to determine the "distance to central business district," to provide transparency of the methodology.

Since the adoption of the quantification methodology in December 2015, ARB has made additional changes for ease-of-use; no equations or methods have been changed. This Version 2 quantification methodology reflects the changes, including:

- Development of an Excel-based calculator tool to simplify the use of the quantification methodology, referred to as the AHSC GHG calculator and described in sections B and C.
- Addition of an example project, provided in Appendix A.
- Clarification of default parking rates for calculating PDT-1 in CalEEMod, provided in Appendix B.
- Guidance for estimating weekly auto trips eliminated by pedestrian facilities, provided in Section C.

Note:

CAPCOA is currently preparing updates to CalEEMod; however, CalEEMod Version 2013.2.2 must be used with this quantification methodology. ARB may revise this document to reflect an updated CalEEMod model for use in FY 2016-17.

AHSC Project Types

The AHSC Program will reduce GHG emissions through projects that implement land use, housing, and transportation strategies to support infill, compact, and affordable housing development projects. The AHSC Program identifies three project types: Transit Oriented Development (TOD), Integrated Connectivity Projects (ICP), and Rural Innovation Project Areas (RIPA). For GHG quantification purposes, projects that include affordable housing or housing related infrastructure will primarily use CalEEMod. Projects without a housing-related component will use the methodologies from the TAC Methods.

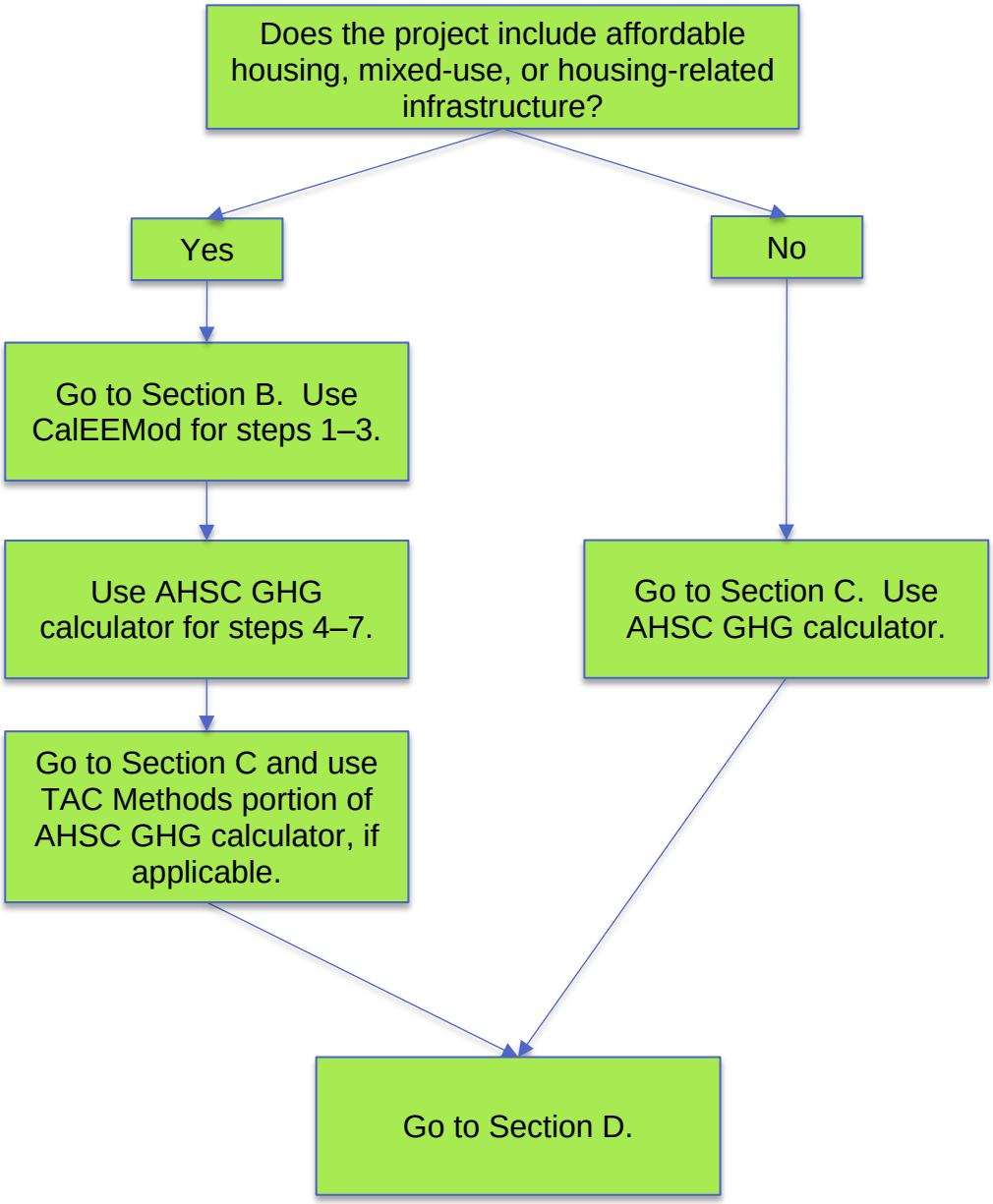
Table 1 lists the most common project types SGC expects to receive in the AHSC Program and identifies which quantification method would likely be used. For some projects, it may be appropriate to use both methods. Appendix A includes an example project that uses both methods.

Table 1. Example Project Features and Quantification Method

AHSC Project Features	CalEEMod	TAC Methods
Affordable housing (including affordable housing developments, housing-related infrastructure, and substantial rehabilitation of housing)	X	
Mixed use development	X	
Transit and commute improvements (e.g., transit subsidy) associated with housing or other land use development	X	
Regional transit projects (e.g., new bus service, vanpools) not associated with housing or other land use development components		X
Bicycle paths or lanes		X
Pedestrian facilities		X
Affordable housing AND vanpool	X	X

Figure 1 outlines the process for calculating the GHG reductions for the proposed project.

Figure 1. Quantification Methodology Flow Chart



GHG Emission Reductions Quantification Approach

This methodology estimates the GHG emission reductions of a proposed AHSC project that are based on the reduction in VMT due to specific project characteristics (e.g., housing density) and project features (e.g., new bus service). Both CalEEMod and the TAC Methods combine project specific data with default data to establish an initial case and a project case. The difference between the initial case and project case is the quantified GHG emission reductions from the VMT reduction features identified in the proposed project.

The metric used to assess the efficiency of the project to reduce GHG emissions per dollar of GGRF funds will be reported by the applicant as:

$$\frac{Total\ Project\ GHG\ Reductions\ in\ Metric\ Tons\ of\ CO_2e}{GGRF\ Funds\ Requested\ (\$)}$$

GGRF Funds Requested is the dollar amount requested through the AHSC Program and any other GGRF programs to which the applicant has applied or may apply. Additional documentation and reporting requirements are provided in sections D and E. The following sections describe the process for estimating the GHG emission reductions for proposed projects in the FY 2015-16 AHSC Program.

Requirements for Program implementation and reporting are subject to change based on future revisions that apply to the Program (e.g., legislation, updates to ARB's Funding Guidelines). Implementing agencies/grantees should note that additional reporting may be required or modified for some types of projects based on the evolving needs of the Program. For example, the requirements and methods of data collection are still under development for Phase 2 reporting and will be published at a later date.

Program Assistance

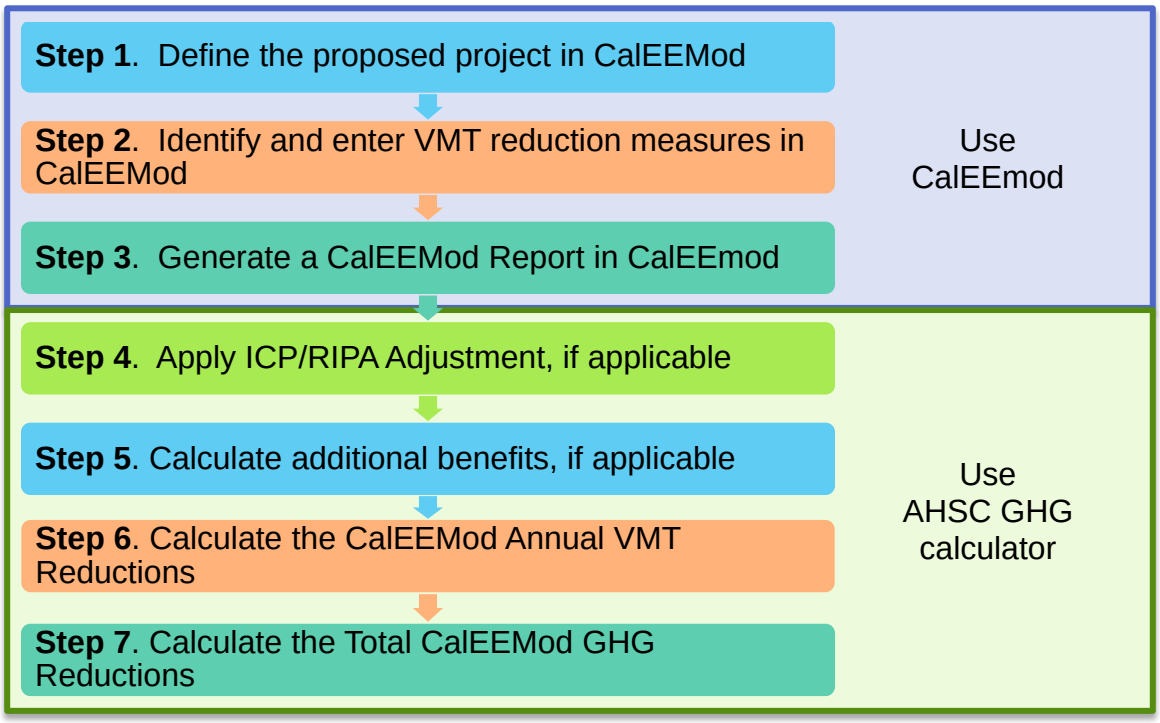
ARB staff will review the quantification portions of the AHSC project applications to ensure that the methods described in this document were properly applied to estimate the GHG emission reductions for the proposed project. Applicants should use the following resources for additional questions and comments:

- Applicants are encouraged to check the frequently asked questions (FAQ) page regularly during the application process, which is at: http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/quantification.htm.
- Questions on this document should be sent to GGRFProgram@arb.ca.gov.
- For more information on ARB's efforts to support implementation of GGRF investments, see: www.arb.ca.gov/auctionproceeds.
- Questions pertaining to the AHSC Program should be sent to ahsc@sgc.ca.gov.

Section B. Quantification Method Using CalEEMod

Applicants will follow the steps outlined in Figure 2 to estimate the VMT reductions for the proposed project using CalEEMod. In CalEEMod, the VMT associated with the initial case is referred to as the "Unmitigated VMT" and the VMT associated with the project case is referred to as the "Mitigated VMT." Use CalEEMod for steps 1 through 3 and the AHSC GHG calculator for steps 4 through 7.

Figure 2. Steps for Estimating VMT Reductions Using CalEEMod

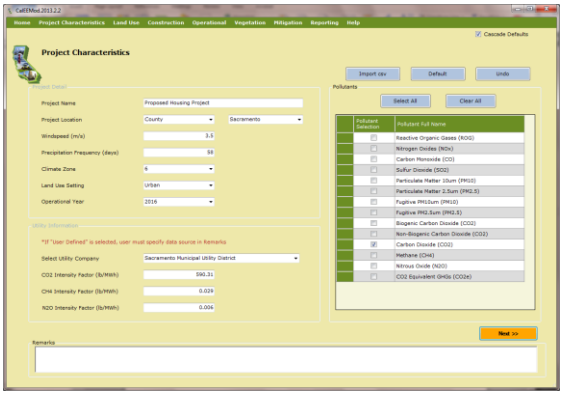


Steps 1—3: Overview

CalEEMod will be used for steps 1 through 3. Refer to the Tools section for more information on CalEEMod and where to obtain the software.

Step 1: Define the Proposed Project

Project Characteristics Screen



Cascade Defaults: Leave this box checked

Project Name: Enter project pin number and project name

Project Location: Select "County" and enter the county of the project site

Climate Zone: Enter any climate zone from the drop-down box[2] (Windspeed and Precipitation will autofill)

Land Use Setting: For RIPA project types, select "Rural;"[3] otherwise, select "Urban"

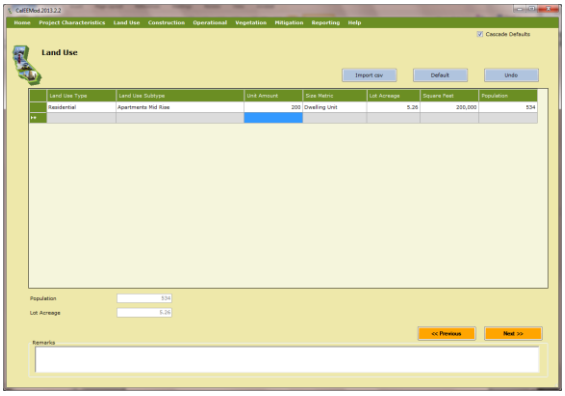
Operational Year: Enter the first year of operation of the proposed project

Select Utility Co.: Select "Statewide Average"[4] (CO_2, CH_4, and N_2O Intensity Factors will autofill)

Pollutants: All boxes can be unchecked[4]

[2] The climate zone for a project can be looked up using CalEEMod's User's Guide Appendix F - Climate Zones Zip Code/Cities Lookup, Climate Zone Zip Code/Cities Lookup or the Climate Zone Map. However, the applicant may enter any allowable climate zone as this information is not used for calculations in this quantification methodology.
[3] The use of "rural" must be consistent with the definition in the AHSC Guidelines.
[4] CalEEMod is used to develop VMT estimates only; GHGs are calculated outside of CalEEMod.

Land Use Screen



Cascade Defaults: Leave this box checked

Land Use Type: Select "Residential" or "Commercial" (See Appendix B) (multiple rows may be used to characterize the proposed project)

Land Use Subtype: See Appendix B (multiple rows may be used to characterize the proposed project)

Unit Amount:

Residential Land Use Types: Enter number of dwelling units
Non-residential Land Use Types: Enter the square footage in thousands (i.e., if the non-residential floor area is 10,000 square feet, enter "10" as the Unit Amount)

Size Metric:

Residential Land Use Types: Select "Dwelling Unit"
Non-residential Land Use Types: Select "1,000 sqft"

Lot Acreage: Leave as default values.[5]

Square Feet: Leave as default values.[5]

Population: Leave as default values.[5]

Applicants should <u>not</u> enter any values into the following screens: Construction, Operational, and Vegetation.

<u>User Tip:</u>
Residential land use types include assumptions on parking; therefore, the applicant does not need to add parking as an additional land use type.

[5] These values are not used in the computation of VMT.

Step 2: Identify and Enter VMT Reduction Measures

Applicants should identify land use and other project features that would result in reduced VMT and enter the applicable project data into the "Land Use & Site Enhancement" or "Commute" screens according to the instructions below.

Mitigation: Traffic, Land Use & Site Enhancement Screen

Project Setting: The Project Setting is used to determine the maximum VMT reductions possible based on the project's location and project-specific features. The Project Settings in CalEEMod are based on the definitions provided in the CAPCOA Quantification Report and are shown in Table 2. For purposes of this quantification methodology, applicants must enter the appropriate Project Setting according to Appendix C. The applicant must provide supporting documentation for the Project Setting selected.

Table 2. Project Settings in the "Land Use & Site Enhancement" Screen

CalEEMod Project Setting Types*	Project Setting Description
Low Density Suburban[6]	**Note: Refer to Appendix C to determine Project Setting Type**
Suburban Center	
Urban	
Urban Center[7]	

*Listed in the order shown in CalEEMod

For RIPA Projects: Select "Low Density Suburban"

Select the VMT reduction measures that apply to the project according to Table 3 for Land Use and Site Enhancement Measures. Note that some of the measures will be calculated in Step 5 (Additional Benefits). For each measure selected, applicants must provide supporting documentation.

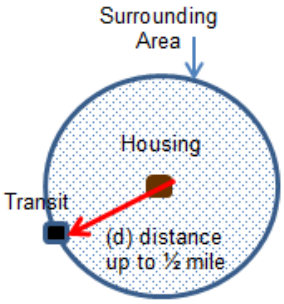
User Tip:
Applicants must check the appropriate box of the measure and enter any necessary data into CalEEMod. Applicants should not check the box of measures calculated outside of CalEEMod or that do not apply to the project.

Mitigation: Traffic, Commute Screen

Select the commute-related measures included in the proposed project and enter the required project specific data as identified in Table 4. Commute measures apply to employees working in the non-residential spaces in mixed-use development projects. Therefore, these measures may only be used with mixed-use development projects. Applicant must be able to demonstrate how these measures would be implemented by the tenant.

[6] Referred to as "Suburban" in the CAPCOA Quantification Report.
[7] Referred to as "Compact Infill" in the CAPCOA Quantification Report.

NOTE: For all measures that rely on features within the project area, the metrics should be evaluated for an area within the housing development and surrounding area which can extend a distance (d) from the housing development not to exceed one-half (½) mile, as shown below. The applicable measures are also denoted with "[(a)]" in Tables 3 and 4 in the "VMT Reduction Measure" column. For example, the VMT Reduction Measure "Improve Walkability Design" indicates the intersections should be evaluated according to this note.



ID[8]	VMT Reduction Measure	
Land Use & Site Enhancement Mea		
LUT-1	Increase Density	H th
LUT-3	Increase Diversity	M
LUT-9[11]	Improve Walkability Design[(a)]	P s

Table 3. "Land Use & Site Enhancement" VMT Reduction Measures

ID[8]	VMT Reduction Measure	Use this Measure if…	Project Specific Data Inputs Required by CalEEMod[9]	Maximum Potential VMT Reduction by Measure[10]	Maximum Potential VMT Reduction by Group[10]
Land Use & Site Enhancement Measures					
LUT-1	Increase Density	Housing development density is greater than 7.6 dwelling units per acre	**Do not use in CalEEMod; See Step 5** Dwelling units per acre of project	30%	Urban: 65% Urban center: 30% Suburban center: 10% Low density suburban: 5%
LUT-3	Increase Diversity	Multiple land use types in project	Select for mixed-use developments (no additional data required)	30%	
LUT-9[11]	Improve Walkability Design[(a)]	Project area has >36 intersections per square mile	**Do not use in CalEEMod; See Step 5** Number of intersections per sq. mi.	21.3%	
LUT-4	Improve Destination Accessibility	Project is within 12 miles of a Central Business District (CBD)	**Do not use in CalEEMod; See Step 5** Distance to CBD (See Appendix D)	20%	
LUT-5	Increase Transit Accessibility	**TOD Project** within 3 miles of Qualifying Transit[12]; **ICP/RIPA Project** within 3 miles of Qualifying Transit AND headways <75 minutes[13]	Distance to transit station (0-2.9 miles)	24.6%	
LUT-6	Integrate Below Market Rate Housing	Project incorporates affordable housing	**Enter Percentage of units (not # of Units)** that are affordable[14] (0-100)	4%[14]	

[8] Measures listed in the order shown on the CalEEMod screens. IDs reference to the CAPCOA Quantification Report.
[9] Values in parentheses indicate valid inputs.
[10] Range of effectiveness derived from the CAPCOA Quantification Report, except as noted.
[11] The Fact Sheet in the CAPCOA Quantification Report lists this measure as LUT-8. There are two measures listed as LUT-8; Improve Walkability Design begins on page 182.
[12] As defined in AHSC Guidelines.
[13] ICP/RIPA projects that do not meet these criteria may not use LUT-5.
[14] The CAPCOA Quantification Report states the maximum reduction potential as 1.2%; however, the maximum reduction potential is 4% (see http://www.montgomeryplanning.org/transportation/documents/TripGenerationAnalysisUsingURBEMIS.pdf). The reduction is applied correctly in CalEEMod.

Table 3. (continued) "Land Use & Site Enhancement" VMT Reduction Measures

ID[8]	VMT Reduction Measure	Use this Measure if…	Project Specific Data Inputs Required by CalEEMod[9]	Maximum Potential VMT Reduction by Measure[10]	Maximum Potential VMT Reduction by Group[10]
Neighborhood Enhancement Measures					
SDT-1	Improve Pedestrian Network[(a)]	Project area includes a pedestrian access network	Designate if improvements are "Project Site" only or "Project Site and Connecting Off-Site"	2%	5%
SDT-2	Provide Traffic Calming Measures[(a)]	Project's streets and intersections feature traffic calming features (Complete Street features)[15]	**Do not use in CalEEMod; See Step 5**	1%	
SDT-3	Implement NEV Network	Project provides viable neighborhood electric vehicle (NEV) network	**Do not use**[16]	12.7%	
Parking Policy/Pricing Measures					
PDT-1	Limit Parking Supply	Project parking requirements are reduced or eliminated	% reduction in residential spaces below ITE avg. weekday parking generation rate[17] (0-100)	20%[18]	20%
PDT-2	Unbundle Parking Costs	Project parking and property costs are separate	Monthly parking cost (0-200)	20%[19]	
PDT-3	On-Street Market Pricing[(a)]	On-street parking utilizes market-rate pricing (such as meters)[20]	% increase in price (0-50)	5.5%	

[15] Applicants will be required to document which traffic calming feature(s) will be implemented in order to take credit for this measure.
[16] Measure removed from use in this quantification methodology. This measure pertains to low-speed, arterial road vehicles, as classified in the California Vehicle Code Section 385.5.
[17] See Appendix B for default ITE parking rates.
[18] The CAPCOA Quantification Report states that the maximum reduction potential is 12.5%; however, CalEEMod allows up to 20% reduction.
[19] The CAPCOA Quantification Report states that the maximum reduction potential is 13% for parking costs of $125; however, CalEEMod allows up to 20% reduction for parking costs of $200.
[20] If the project area will increase parking rates between the time of application to building occupancy and the rate of increase is known, applicants may use this measure. Users may only enter an increase in price up to 50%.

Table 3. (continued) "Land Use & Site Enhancement" VMT Reduction Measures

ID[8]	VMT Reduction Measure	Use this Measure if…	Project Specific Data Inputs Required by CalEEMod[9]	Maximum Potential VMT Reduction by Measure[10]	Maximum Potential VMT Reduction by Group[10]
Transit Improvement Measures					
TST-1	Provide BRT System[(a)]	Establish a Bus Rapid Transit line with operational funding stream[21]	% of lines serving project converting to BRT (0-100)	3.2%	10%
TST-3	Expand Transit Network[(a)]	Establishes or enhances bus line with operational funding stream[21]	% increase transit coverage (0-100)	7.4%[22]	
TST-4	Increase Transit Frequency[(a)]	Reduces headways of existing transit[21]	Level of implementation (percentage of lines improved) (<50% or ≥50%) % reduction in headway (increase in frequency) (0-100)	3.1%	

[21] This measure should not be used if TAC Methods are applied for the same service.
[22] The CAPCOA Quantification Report states the maximum reduction potential as 8.2%; however, the maximum reduction potential is 7.4%.

Table 4. "Commute" VMT Reduction Measures

ID[23]	VMT Reduction Measure	Use this Measure if…	Project Specific Data Inputs Required by CalEEMod[24]	Maximum Potential VMT Reduction by Measure[25]	Maximum Potential VMT Reduction by Group[25]
Commute Trip Measures					
TRT-1&2	Implement Trip Reduction Program	TMA membership or other comprehensive services	% employees eligible Enter program type as **Voluntary** (0-100)	6.2%	25% of Work VMT
TRT-4	Transit Subsidy[26]	Proponent subsidizes sustainable modes of transportation for employees	% employees eligible (0-100) and daily transit subsidy amount ($)[27]	20.0%	
TRT-15	Implement Employee Parking "Cash-Out"	Employer provides cash-value of a parking space to employees who do not use one	% employees eligible (0-100)	7.7%	
TRT-14	Workplace Parking Charge	Charge employees for their parking	% employees eligible (0-100) and daily parking charge ($)	19.7%	
TRT-6	Encourage Telecommuting and Alternative Work Schedules	Allow/require 9/80s, 4/40, or telecommuting	% employees work 9/80, % employees work 4/40, or % employees telecommute 1.5 days (Total percentage 0-100)	5.5%	
TRT-7	Market Commute Trip Reduction Option	Market sustainable travel options	% employees eligible (0-100)	4.0%	
TRT-11	Employee Vanpool/Shuttle	Provide employer-sponsored vanpool or shuttle program	**Do not use in CalEEMod. Apply TAC Methods**	13.4%	
TRT-3	Provide Ride Sharing Program	Establish a carpooling program with associated infrastructure	% employees eligible (0-100)	15%	

[23] Measures listed in the order shown on the CalEEMod screens. IDs reference to the CAPCOA Quantification Report.
[24] Values in parentheses indicate valid inputs.
[25] Range of effectiveness derived from the CAPCOA Quantification Report, except as noted.
[26] TRT-4 is used for subsidized transit passes for employees. For subsidized transit passes for residents, see Step 5.
[27] The subsidy must be provided on an annual basis and be funded for a minimum of three years. For annualized rates, refer to Table 5.

Step 3: Generate a CalEEMod Report

Reporting Screen

Select "Annual" emissions

Click "Recalculate Emissions and Run Report"

User Tip:
GHG emissions are calculated outside of CalEEMod based on the VMT estimates generated in CalEEMod.

CalEEMod will generate a report that includes annual Total VMT estimates for the project for both the initial case, which is identified as "unmitigated" in the CalEEMod report, and the project case, identified as "mitigated." The VMT outputs are found in the Section 4.2 as shown in Figure 3. The unmitigated annual VMT is the estimated VMT that would occur if the project did not include the mitigation features selected in CalEEMod; the mitigated annual VMT accounts for the land use and commute features selected. These CalEEMod outputs will be used as inputs to the ARB-developed AHSC GHG calculator, which is described in steps 4 through 7.

Figure 3. CalEEMod Report Section 4.2 VMT Output

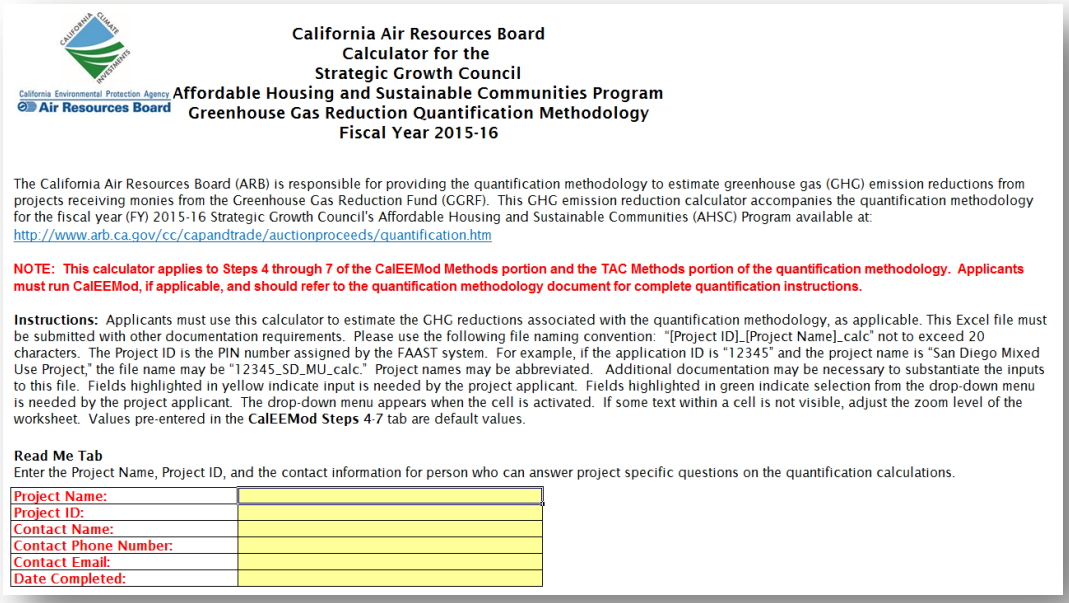
4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Apartments Mid Rise	659.00	716.00	607.00	1,882,065	1,466,443
Total	659.00	716.00	607.00	1,882,065	1,466,443

Applicants must submit both the input and output files used to generate the VMT data, in Excel format. Applicants are requested to name the input and output files using the following format: "[Pin#]_[ProjectName]_input/output" not to exceed 20 characters. For example, if the application pin number is "12345," the project name is "San Diego Bay Housing," and the file is the input file, the file name may be "12345_SDBay_input." Project names may be abbreviated.

Steps 4—7: Overview

Applicants must use the Excel-based AHSC GHG calculator for steps 4 through 7. The equations used in the calculations are based on CalEEMod and the CAPCOA Quantification Report and are provided in Appendix E. The AHSC GHG calculator can be downloaded from the GGRF website at: http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/quantification.htm. Applicants must begin with the **Read Me** tab, which contains instructions and prompts users to enter project information.



California Air Resources Board
Calculator for the
Strategic Growth Council
Affordable Housing and Sustainable Communities Program
Greenhouse Gas Reduction Quantification Methodology
Fiscal Year 2015-16

The California Air Resources Board (ARB) is responsible for providing the quantification methodology to estimate greenhouse gas (GHG) emission reductions from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). This GHG emission reduction calculator accompanies the quantification methodology for the fiscal year (FY) 2015-16 Strategic Growth Council's Affordable Housing and Sustainable Communities (AHSC) Program available at:
http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/quantification.htm

NOTE: This calculator applies to Steps 4 through 7 of the CalEEMod Methods portion and the TAC Methods portion of the quantification methodology. Applicants must run CalEEMod, if applicable, and should refer to the quantification methodology document for complete quantification instructions.

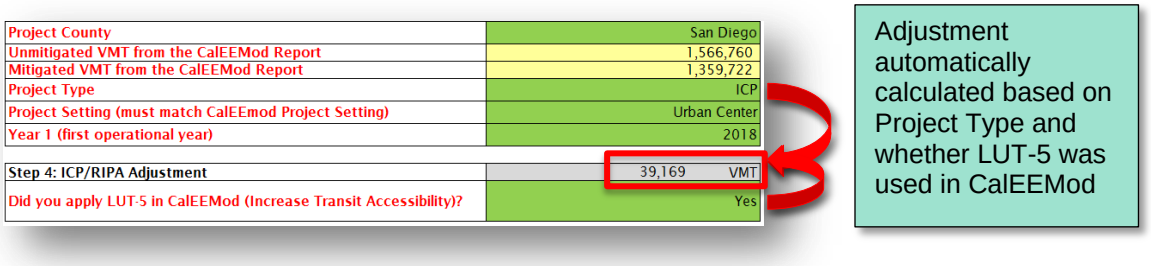
Instructions: Applicants must use this calculator to estimate the GHG reductions associated with the quantification methodology, as applicable. This Excel file must be submitted with other documentation requirements. Please use the following file naming convention: "[Project ID]_[Project Name]_calc" not to exceed 20 characters. The Project ID is the PIN number assigned by the FAAST system. For example, if the application ID is "12345" and the project name is "San Diego Mixed Use Project," the file name may be "12345_SD_MU_calc." Project names may be abbreviated. Additional documentation may be necessary to substantiate the inputs to this file. Fields highlighted in yellow indicate input is needed by the project applicant. Fields highlighted in green indicate selection from the drop-down menu is needed by the project applicant. The drop-down menu appears when the cell is activated. If some text within a cell is not visible, adjust the zoom level of the worksheet. Values pre-entered in the **CalEEMod Steps 4-7** tab are default values.

Read Me Tab
Enter the Project Name, Project ID, and the contact information for person who can answer project specific questions on the quantification calculations.

Project Name:	
Project ID:	
Contact Name:	
Contact Phone Number:	
Contact Email:	
Date Completed:	

Step 4: ICP/RIPA Adjustment

The data supporting transit accessibility (LUT-5) in CalEEMod are based on high-quality transit service. Since ICP and RIPA projects by definition per AHSC Guidelines do not include high-quality transit, an adjustment is needed for these projects. Therefore, this adjustment only applies to ICP and RIPA projects that are taking credit for LUT-5 in CalEEMod. The adjustment will be calculated automatically based on the Project Type and whether LUT-5 was applied in CalEEMod.[28]



Project County	San Diego
Unmitigated VMT from the CalEEMod Report	1,566,760
Mitigated VMT from the CalEEMod Report	1,359,722
Project Type	ICP
Project Setting (must match CalEEmod Project Setting)	Urban Center
Year 1 (first operational year)	2018
Step 4: ICP/RIPA Adjustment	39,169 VMT
Did you apply LUT-5 in CalEEMod (Increase Transit Accessibility)?	Yes

Adjustment automatically calculated based on Project Type and whether LUT-5 was used in CalEEMod

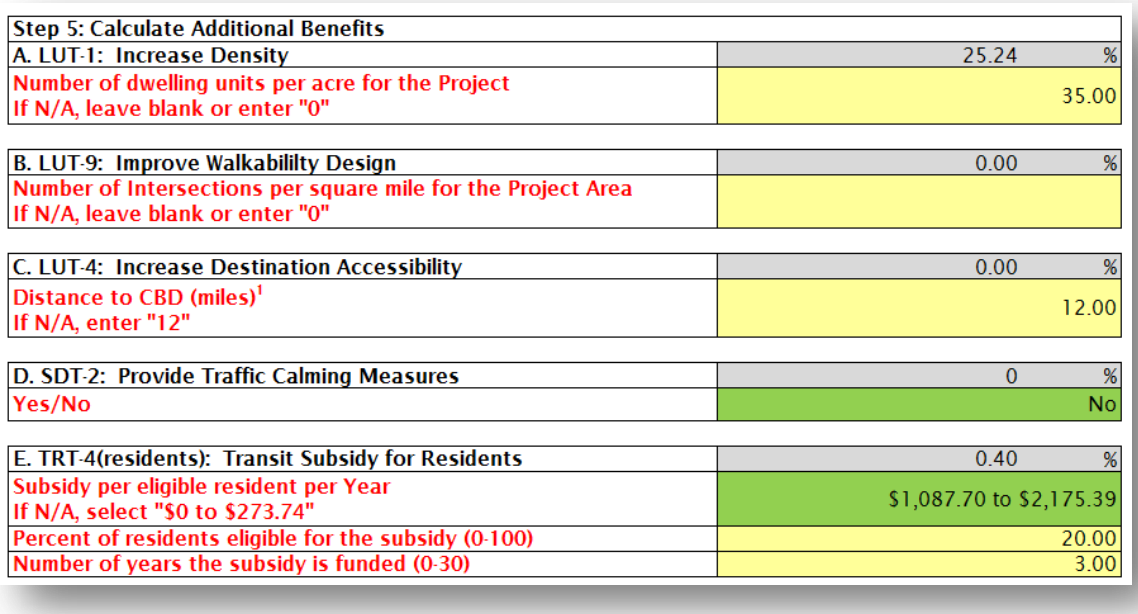
[28] Based on documentation in the CAPCOA Quantification Report for TST-4: Increase Transit Frequency/Speed

Step 5: Calculate Additional Benefits

Applicants should enter the requested information for the measures that apply to the project. The AHSC GHG calculator will display the percent VMT reductions by measure. For measures that do not apply to the project, inputs should be left as defaults, resulting in no change to VMT for the measure(s).

The AHSC GHG calculator provides additional benefits for the following measures if applicable to the proposed project, as described in Tables 3 and 4:

A. LUT-1: Increase Density
B. LUT-9: Improve Walkability Design
C. LUT-4: Improve Destination Accessibility (see Appendix D for estimating Distance to CBD)
D. SDT-2: Provide Traffic Calming Measures
E. TRT-4(residents): Transit Subsidy for Residents. Note: The CalEEMod Transit Subsidy is applicable to non-residential land use types (for employees). This adjustment has been provided to apply transit subsidies to residents.



Step 5: Calculate Additional Benefits		
A. LUT-1: Increase Density	25.24	%
Number of dwelling units per acre for the Project If N/A, leave blank or enter "0"	35.00	
B. LUT-9: Improve Walkabililty Design	0.00	%
Number of Intersections per square mile for the Project Area If N/A, leave blank or enter "0"		
C. LUT-4: Increase Destination Accessibility	0.00	%
Distance to CBD (miles)[1] If N/A, enter "12"	12.00	
D. SDT-2: Provide Traffic Calming Measures	0	%
Yes/No	No	
E. TRT-4(residents): Transit Subsidy for Residents	0.40	%
Subsidy per eligible resident per Year If N/A, select "$0 to $273.74"	$1,087.70 to $2,175.39	
Percent of residents eligible for the subsidy (0-100)	20.00	
Number of years the subsidy is funded (0-30)	3.00	

Step 6: Calculate the CalEEMod Annual VMT Reductions

This Step calculates the annual VMT reductions according to the project features and the maximum potential reductions according to the Project Setting and listed in Table 5. This Step is automated and no user input is required.

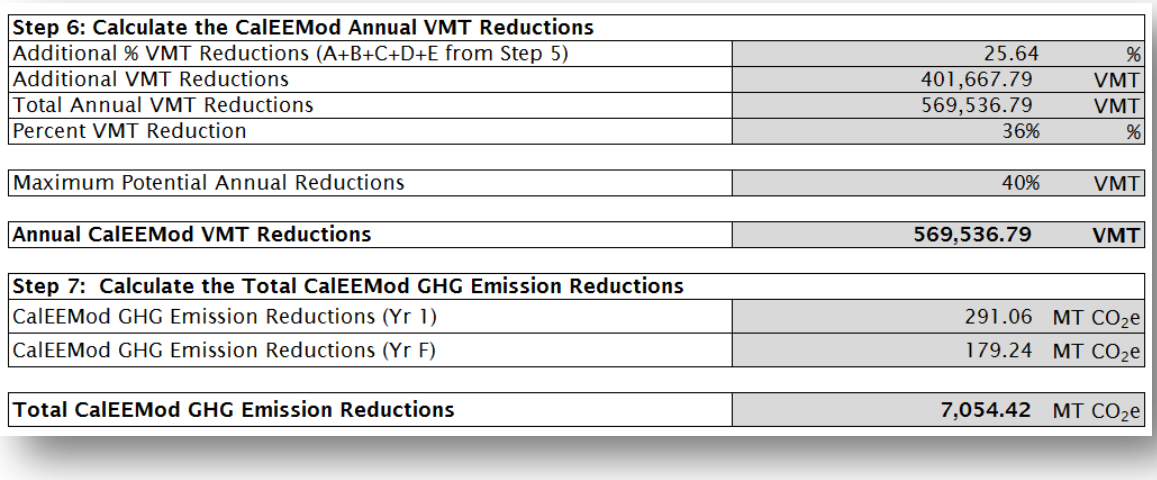
Table 5. Maximum Potential Reductions by Project Setting Type

CalEEMod Project Setting Types*	Maximum Potential Reductions (Total maximum project VMT reduction)[29]
Low Density Suburban	15%
Suburban Center	20%
Urban Center	40%
Urban	75%

*Listed in order of increasing maximum potential reductions

Step 7: Calculate the Total CalEEMod GHG Reductions

This Step converts the annual VMT reductions to annual GHG reductions and calculates the GHG reductions over the life of the project, 30 years. This Step is automated and no user input is required. Information on the emission factors used to convert VMT reductions to GHG emission reductions is available in Appendix F.



Step 6: Calculate the CalEEMod Annual VMT Reductions		
Additional % VMT Reductions (A+B+C+D+E from Step 5)	25.64	%
Additional VMT Reductions	401,667.79	VMT
Total Annual VMT Reductions	569,536.79	VMT
Percent VMT Reduction	36%	%
Maximum Potential Annual Reductions	40%	VMT
Annual CalEEMod VMT Reductions	**569,536.79**	**VMT**
Step 7: Calculate the Total CalEEMod GHG Emission Reductions		
CalEEMod GHG Emission Reductions (Yr 1)	291.06	MT CO_2e
CalEEMod GHG Emission Reductions (Yr F)	179.24	MT CO_2e
Total CalEEMod GHG Emission Reductions	**7,054.42**	MT CO_2e

If your project has features requiring use of TAC Methods, go to **Section C. TAC Methods**; otherwise, go to **Section D. Documentation**.

[29] As defined in the CAPCOA Quantification Report. The interactions among transportation-related measures are complex and sometimes counter-intuitive. The maximum reduction values are derived from the percentage difference in per capita VMT compared against a statewide average and reflect the highest reduction levels justified by the literature as reviewed for the CAPCOA Quantification Report.

Section C. Quantification Method for Using Transit and Connectivity Methods

Transit and Connectivity Methods (TAC methods) are provided for new or expanded transportation service project features that are not quantified in CalEEMod. Applicants should identify the applicable TAC method(s) as described in Table 6 based on the proposed project features.

Table 6. TAC Methods by Project Type

Project Type	Operation of New/Expanded Bus, Train, Ferry, Vanpool, or Shuttle Service	Bicycle Paths, Bicycle Lanes, or Pedestrian Facilities
Description	Cleaner vehicles that service fixed-routes; commuter vanpools; or tourist or shopping shuttles to work sites, homes, or schools	Bicycle Paths (Class 1) or Bicycle Lanes (Class 2), or Pedestrian Facilities, that are targeted to reduce commute and other non-recreational auto travel
TAC Method	$GHG\ Emission\ Reductions = GHG\ Emissions\ of\ Displaced\ Autos - GHG\ Emissions\ of\ New/Expanded\ Service\ Vehicle$	$GHG\ Emission\ Reductions = GHG\ Emissions\ of\ Displaced\ Autos$

Note: The AHSC Program estimates GHG reductions associated with a decrease in VMT from a new or expanded transportation service. GHG reductions associated with replacement of vehicles in an existing service are not quantified.

AHSC GHG Calculator

Applicants must use the AHSC GHG calculator to determine GHG reductions associated with TAC Methods. The equations used to estimate VMT in the calculations are based on the CMAQ Method and are provided in Appendix E. Information on the emission factors used to convert VMT reductions to GHG emission reductions is available in Appendix F. The AHSC GHG calculator can be downloaded from http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/quantification.htm.

Begin with the **Read Me** tab, which contains instructions and prompts users to enter project information. Year 1 refers to the first operational year of the new service. For projects that do not require ongoing operational funds (bicycle lanes/paths and pedestrian facilities), Year F is calculated automatically based on the estimated life of the facility (20 years for Class 1 bicycle lanes and pedestrian facilities and 15 years for Class 2 bicycle facilities). For projects that do require ongoing operational funds, Year F refers to the last year of enforceable committed funds for operation of the new/expanded service. These and other definitions are provided in the **Definitions** tab of the AHSC GHG calculator.

Table 7 indicates which factors in the **TAC Inputs** tab require input from the applicant ("✓"), and which values are either not applicable or have default values programmed into the AHSC GHG calculator (shaded cells).

Table 7. Input Requirements by Project Type for TAC Methods

Description	Project-Level Data Required				
	Bus/ Shuttle/ Vanpool	Train	Ferry	Bike	Pedestrian
Year 1	✓	✓	✓	✓	✓
Year F[a]	✓	✓	✓		
Days of operation per year of new service (D)	260 (weekday service) 365 (daily service)	✓	✓	200	
Daily ridership of new service (R)[b]	✓	✓	✓		
Adjustment factor to account for transit dependency (A)		✓	✓		
Length of average auto trip reduced (L)		✓	✓		
Adjustment factor to account for auto trips used to access new service (AA)		✓	✓		
Length of average trip for auto access to transit (LL)		✓	✓		
Average Daily Traffic (ADT)				✓	
Bicycle Paths/Lanes ADT Adjustment Factor (A)				✓	
Bicycle Paths/Lanes Activity Center Credit (C)				✓	
Pedestrian Weekly Auto Trips Eliminated					✓[c]
Fuel Type of New Service	✓	✓	✓		
Engine Model Year of New Service	✓				
Annual VMT/ Units of Fuel	✓ (VMT)	✓ (VMT)	✓ (Fuel)		

[a] Year F is the last year of enforceable committed funds for the operation of the new/expanded service.

[b] If the Ridership will vary over the life of the project, the AHSC GHG calculator allows different inputs for Year 1 and Year F. If the ridership is not expected to change, the same value should be input for Year 1 and Year F.

[c] There is no required method to estimate the weekly auto trips eliminated by pedestrian facilities. Applicants should develop a "reasonable estimate" based on project features and amenities; the supporting documentation will be reviewed during the application process. As an example, if a new housing development project includes installation of a sidewalk connecting the development to a grocery store 0.2 miles away, it may be reasonable to assume a proportion of the residents will walk to and from the store weekly, thereby eliminating auto trips. An applicant who assumes 15% of 100 residents will walk to the store once a week instead of driving would result in 30 auto trips eliminated per week (15 residents walking each way results in 30 one-way trips). A similar project that includes installation of a sidewalk connecting a housing development to a transit center may result in 5% of 100 residents walking to the station five days per week instead of driving. This would result in 50 auto trips eliminated per week. Longer distances to amenities would likely result in lower expected trips per week. The TAC Methods assume a default "Length of auto trip eliminated" of one mile; therefore, one mile is used in the AHSC calculator regardless of the actual distance to the amenity.

Project Details							
Transit and Connectivity Method	County	Year 1 (Yr 1)	Year F (Yr F)	Annual Days of Operation (D)	Yr 1 Daily Ridership (R)	Yr F Daily Ridership (R)	Adjustment factor (A)
Shuttle	Butte	2018	2020	260	1,000	1,000	

	GHGs of New Service Vehicle			Net Benefits	
Pedestrian Yr F Weekly Auto Trips Eliminated	Fuel Type	Engine MY	Annual VMT/ Units of Fuel	Total GHG Emission Reductions (MTCO2e)	Average Annual Auto VMT Reduced
	Hydrogen Fuel Cell	2017	12,000	2,679.87	2,643,550.00

Once the TAC Methods have been completed, go to **Section D. Documentation**.

Section D. Documentation

Applicants must report the Total Project GHG Emission Reductions estimated in the calculator tool. Applicants are required to provide electronic documentation that is complete and sufficient to allow the calculations to be reviewed and replicated. Paper copies of supporting materials must be available upon request by ARB staff.

The following checklist is provided as a guide to applicants; additional data and/or information may be necessary to support project-specific input assumptions. Documentation is required by all applicants for #1-8; however, some documentation may not be applicable to certain applicants (for example, #11 may not be applicable to housing-only projects).

	Documentation Description	Completed
1.	Contact information for the person who can answer project specific questions from staff reviewers on the quantification calculations	
2.	Project description, including excerpts or specific references to the location in the main AHSC application of the project information necessary to complete the applicable portions of the quantification methodology	
3.	Populated calculator tool file (in .xlsm)	
4.	If the Total GGRF funds requested are different than the AHSC GGRF funds requested, provide an explanation of the other GGRF program(s) where funding is sought, including the fiscal year of the application(s)	
5.	Electronic copies of the CalEEMod input and output files as described in Step 3 of Section B • A list of the VMT reduction measures used in the proposed project with clearly identified project specific input data used in Section B • Documentation for determining Distance to Central Business District and Project Setting Type	
6.	Any other information as necessary and appropriate to substantiate inputs (e.g., Project Setting or Ridership)	

Total Project GHG Emission Reductions is equal to the sum total of each of the GHG Reductions calculated in Sections B and C and are automatically summed in the AHSC GHG calculator in the **GHG Summary** tab.

Total Project GHG Emission Reductions per dollars of AHSC requested is calculated as:

$$\frac{Total\ Project\ GHG\ Emission\ Reductions\ in\ Metric\ tons\ (MT)\ of\ CO_2e}{AHSC\ Funds\ Requested\ (\$)}$$

Applicants should enter the AHSC Funds Requested ($) into the AHSC GHG calculator for all project features. The AHSC GHG calculator will provide the Total GHG Emission Reductions per AHSC Funds Requested.

Total Project GHG Emission Reductions per dollars of GGRF requested is calculated as:

$$\frac{Total\ Project\ GHG\ Emission\ Reductions\ in\ Metric\ tons\ (MT)\ of\ CO_2e}{Total\ GGRF\ Funds\ Requested\ (\$)}$$

Applicants should enter the GGRF Funds Requested ($) into the AHSC GHG calculator for all project features. The AHSC GHG calculator will provide the Total GHG Emission Reductions per GGRF Funds Requested.

The dollars requested from AHSC may be different from the dollars requested from GGRF if the applicant has applied for, anticipates applying for, or received funding for the proposed project through a separate GGRF program. If no other GGRF funds are requested, the Total Project GHG Emissions Reductions per dollars of GGRF and AHSC will be the same.

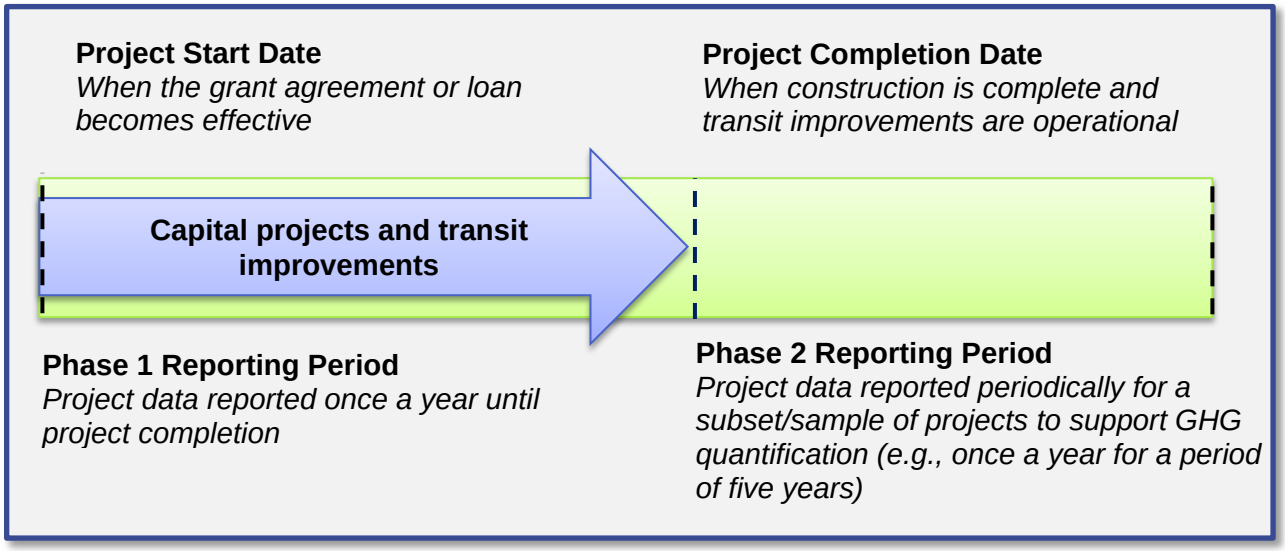
Applicants are required to provide electronic documentation that is complete and sufficient enough to allow the quantification calculations to be reviewed and replicated. Paper copies of any materials must be available upon request by SGC or ARB staff.

Section E. Reporting after Funding Award

Accountability and transparency are essential elements for all projects funded by the GGRF. Each administering agency is required to track and report on the benefits of the California Climate Investments funded under their program(s) and each funding recipient has the obligation to provide the necessary data or access to data for their project to support reporting on project outcomes.

In 2015, ARB developed Funding Guidelines for Agencies Administering California Climate Investments (Funding Guidelines).[30] The Funding Guidelines describe the reporting requirements and set the minimum project-level reporting requirements for projects funded by SGC. Volume III of the Funding Guidelines summarizes the major reporting components that SGC must report to ARB. Because much of this data comes directly from AHSC projects, AHSC funding recipients will need to provide project data to SGC to support these reporting requirements.

The figure below and Table 8 show the project phases and when reporting is required.



[30] California Air Resources Board. Funding Guidelines for Agencies that Administer California Climate Investments, December 21, 2015 available at: http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/arb-funding-guidelines-for-ca-climate-investments.pdf.

Table 8. Quantification and Reporting By Project Phase

	Timeframe	Quantification Methodology Section
Project Selection	Covers the period from solicitation to selection of projects and funding awards	All applicants use methods in this QM to **estimate** GHG reductions based on application data.
Phase 1	Covers the period from the beginning of the project until it becomes operational or the initial implementation is completed	Funded projects use methods in this QM, as needed, to update GHG **estimates** based on project changes.
Phase 2	Starts after Phase 1 is complete and a project becomes operational	GHG reductions **achieved** are quantified and reported for a subset of funded projects.

Phase 1 reporting is required for all AHSC funding recipients during project implementation (e.g., initial construction). This quantification methodology provides guidance on how to estimate project benefits to satisfy Phase 1 reporting requirements. At a minimum, ARB expects that AHSC funding recipients will report to SGC once a year during project construction (for projects with a capital component) or during implementation (for transit without a capital component) and once at the end of the project.

Phase 2 reporting is required for only a subset of AHSC projects and is intended to document actual project benefits achieved after the project becomes operational. Phase 2 data collection and reporting will not be required for every project. SGC will be responsible for identifying the subset of individual projects that must complete Phase 2 reporting, identifying who will be responsible for collecting Phase 2 data, and for reporting the required information to ARB. ARB will work with SGC to address "Phase 2" procedures, including but not limited to:

- The **timelines** for Phase 2 reporting, i.e., when does Phase 2 reporting begin, how long will Phase 2 reporting be needed.
- As applicable, **approaches for determining the subset of projects** that need Phase 2 reporting (i.e., how many **X** projects out of **Y** total projects are required to have Phase 2 reporting).
- **Methods for monitoring or measuring** the necessary data to quantify and document achieved GHG reductions and other select project benefits.
- **Data to be collected**, including data field needed to support quantification of GHG emission benefits.
- Reporting requirements for transmitting the data to ARB or SGC for program transparency and use in reports.

Once the Phase 2 quantification method and data needs are determined ARB will develop and post the final ARB approved Phase 2 methodology for use in Phase 2 reporting.

Appendix A. Example Project

Introduction

The following is a hypothetical project[31] to demonstrate how the FY 15-16 Affordable Housing and Sustainable Communities Program Quantification Methodology would be applied. This example does not provide examples of the supporting documentation that is required of actual project applicants.

Overview of the proposed project

The proposed project is a collaborative **TOD** project between a housing developer and a transit agency, proposing the following components:

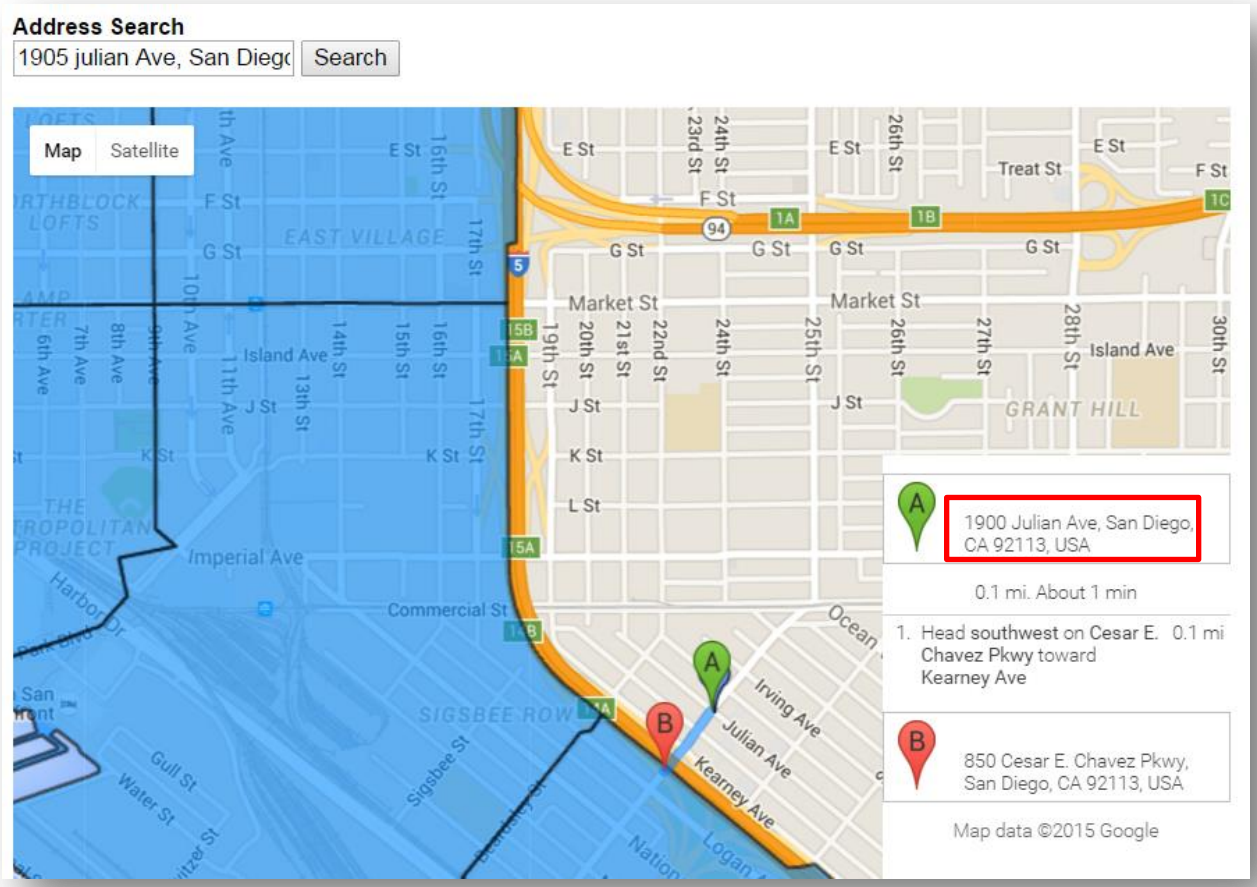
- Mixed-use development with affordable housing
- New bus service

The proposed project is located in San Diego County with the following project features:

- First year of development operation: 2018.
- 4-story rental development with 80 units; 75% are affordable.
- 3,000 square feet of commercial use. No tenant is committed to the property; therefore, no reduction measures associated with the commercial development can be guaranteed (i.e., no measures will be applied on the "commute" screen in CalEEMod).
- 2.5 acres (32 dwelling units per acre).
- 1 parking space per dwelling unit (ITE default average weekday parking rate for a mid-rise urban apartment is 1.2 spaces per dwelling unit. This quantification methodology is requiring reductions from residential only; therefore, the project has a reduction in parking spaces of 18.7% [(1-1.23)/1.23]).
- The new hydrogen-powered bus service would be funded by AHSC funds for three years and therefore can demonstrate 3 years of operational funds. No subsidy is provided to riders.
- The new bus service would begin operation in 2018 and consist of 2 model year 2018 buses, with a ridership of 500 passengers per day on a daily service schedule.
- The new bus service would run 30,000 miles (total for 2 buses) per year.
- The application request is for $5,000,000 from the AHSC Program. No other GGRF funding is being or has been sought.
- The distance to the nearest Central Business District (CBD) is 0.1 miles, as shown on the next page.
- PIN number assigned by FAAST system: 12345.

[31] The hypothetical project has not undergone verification of any AHSC Program requirements; all assumptions about location type and features are for quantification methodology demonstration purposes only.

Refer to Appendix D for instructions on estimating Distance to CBD.



Methods to apply

According to Table 1 in the Quantification Methodology, the applicant would use CalEEMod for the development portion of the project and TAC Methods for the new bus service.

As described in Section A of the quantification methodology, users can download CalEEMod for free at www.caleemod.com. For Steps 4 through 7 of the CalEEMod component, the TAC Methods component, and some of the documentation components, ARB has developed an Excel-based calculator. All applicants must use the calculator for the applicable components of their project. The calculator is available at ARB's Auction Proceeds Quantification Page, under the Strategic Growth Council's Affordable Housing and Sustainable Communities Program: http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/quantification.htm.

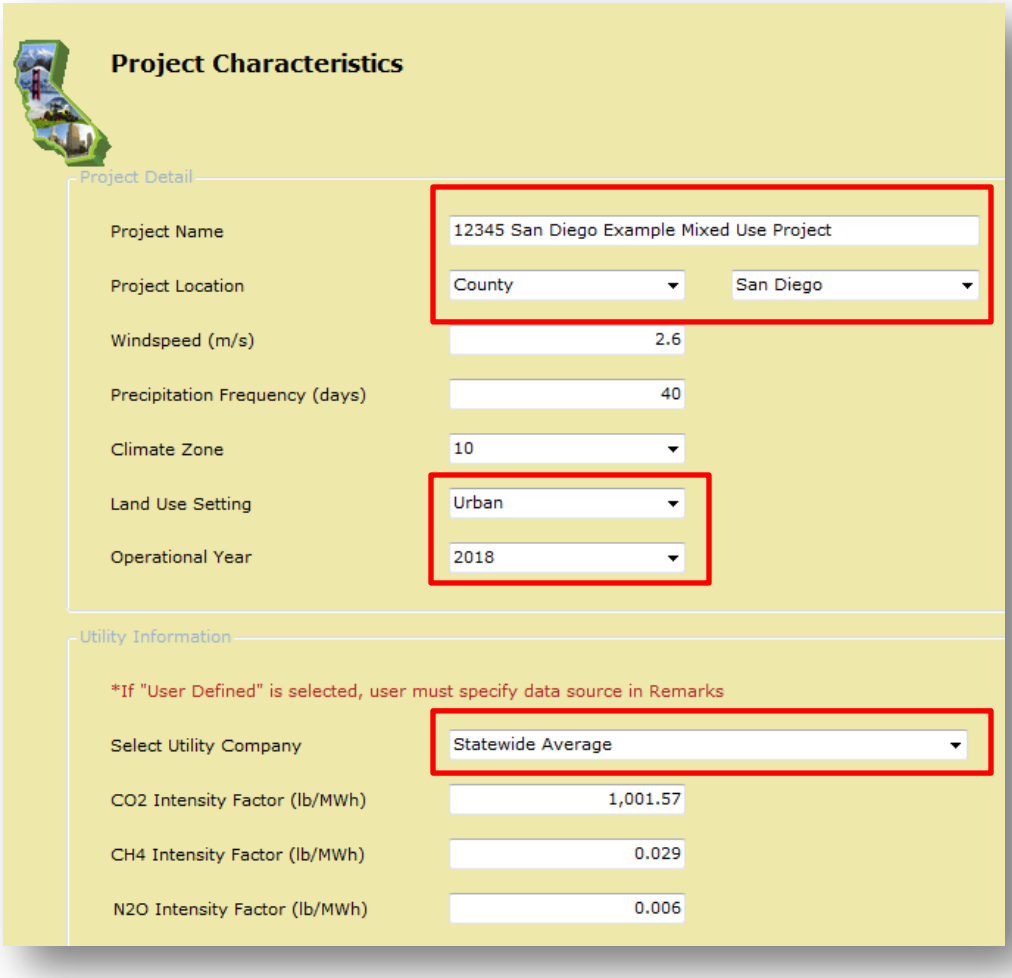
CalEEMod component

Step 1: Define the proposed project in CalEEMod

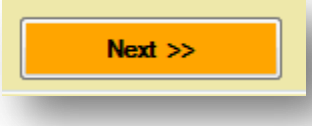
Project Characteristics Screen

Note: Include PIN number in Project Name

Project Name: 12345 San Diego Example Mixed Use Project
Project Location: "County" and San Diego
Climate zone: Choose any allowable zone
Land Use Setting: This is not a RIPA project, so select "Urban"
Utility: Statewide Average
Pollutants: All pollutants may be de-selected



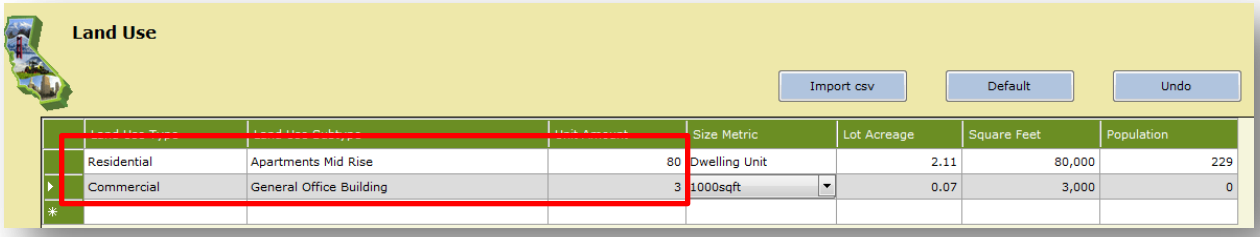
Click "Next."



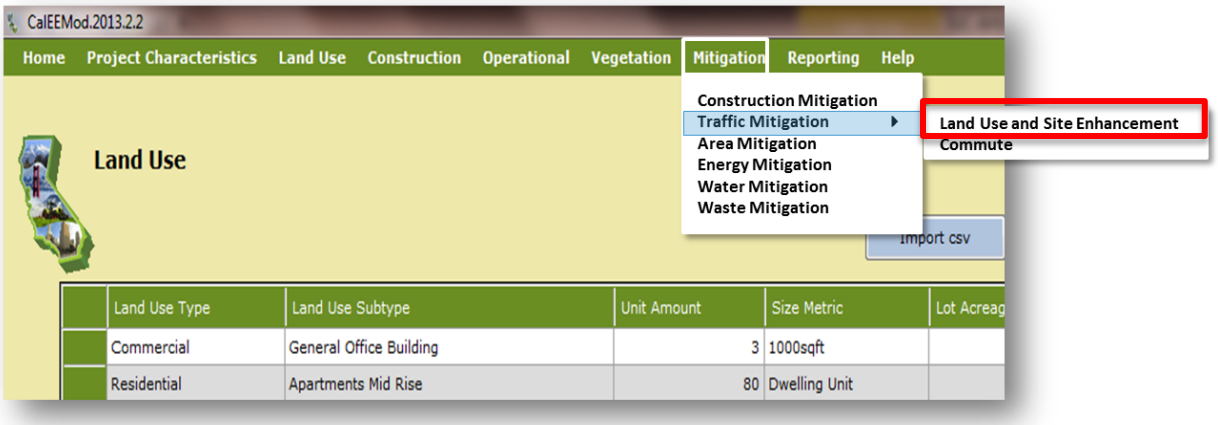
Land Use Screen

Refer to Appendix B to determine the appropriate Land Use Type and Land Use Subtype for each project component. Since the proposed project is a four-story rental apartment, it is classified as "Apartment Mid Rise" and all non-residential property is classified as "General Office Building."

Line 1: Residential, Apartment Mid-rise, "80" for the number of dwelling units
Line 2: Commercial, General Office Building, "3" for "thousands of square feet"



Select "Mitigation" > "Traffic Mitigation" > "Land Use and Site Mitigation."



Step 2: Identify and Enter VMT Reduction Measures

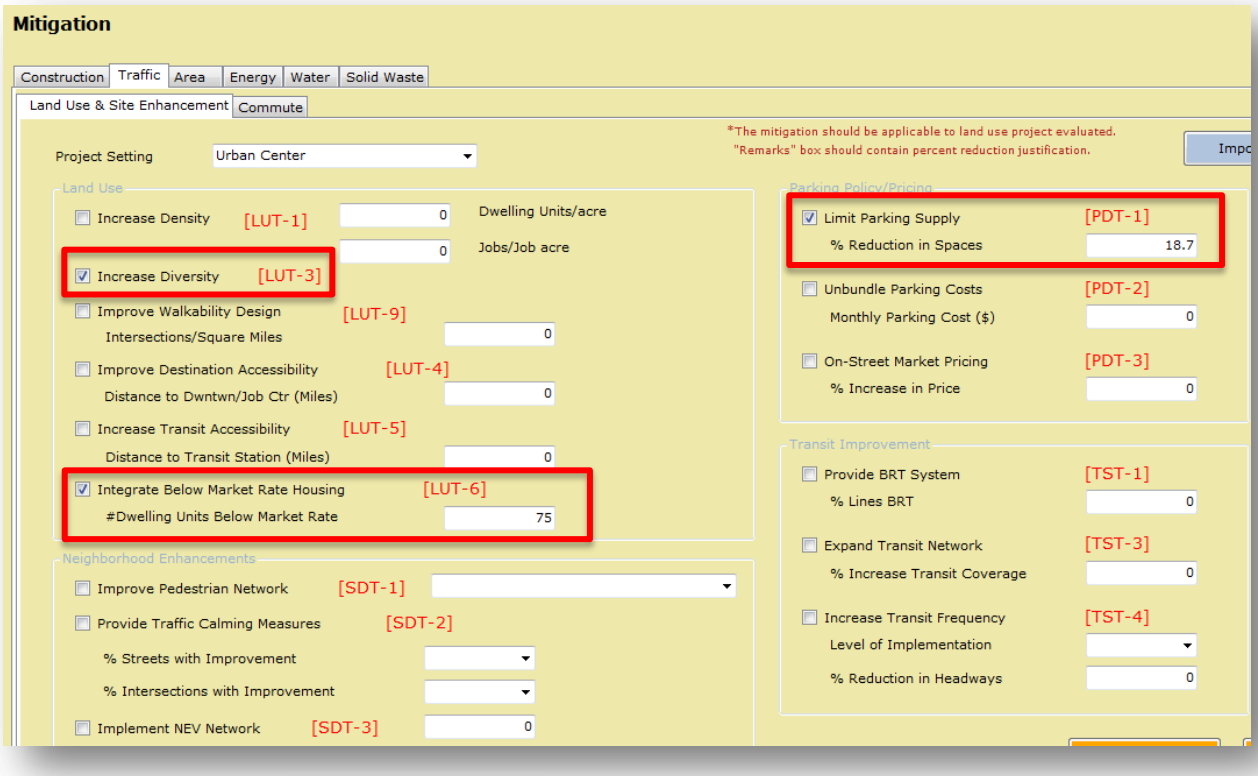
Mitigation: Traffic, Land Use & Site Enhancement Screen

Refer back to Table 3 of the quantification methodology for additional information by measure. Note: CalEEMod may prompt the user to enter "Remarks" on some screens. These will not be reviewed as the supporting documentation for inputs.

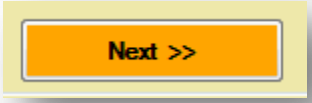
Project Setting: "Urban Center"[32]
The project has the following features:
LUT-1, LUT-3, LUT-4, LUT-6, and PDT-1.
LUT-1 and LUT-4 are calculated outside of CalEEMod and must not be selected in CalEEMod.

Enter the following in CalEEMod:
LUT-3: Check the box.
LUT-6: Check box and enter "75" for percent of units below market rate.
PDT-1: Check the box and enter "18.7" for percent reduction in spaces.

The other measures will be estimated in Step 5.



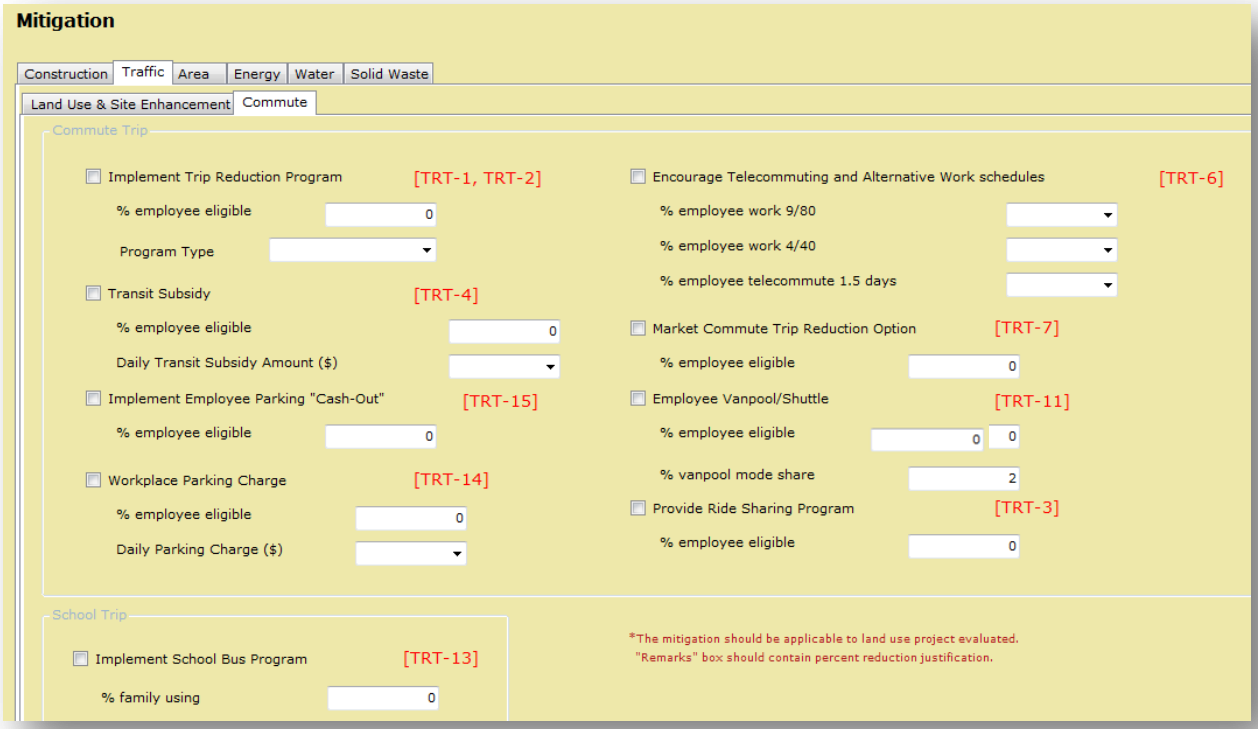
Click "Next."



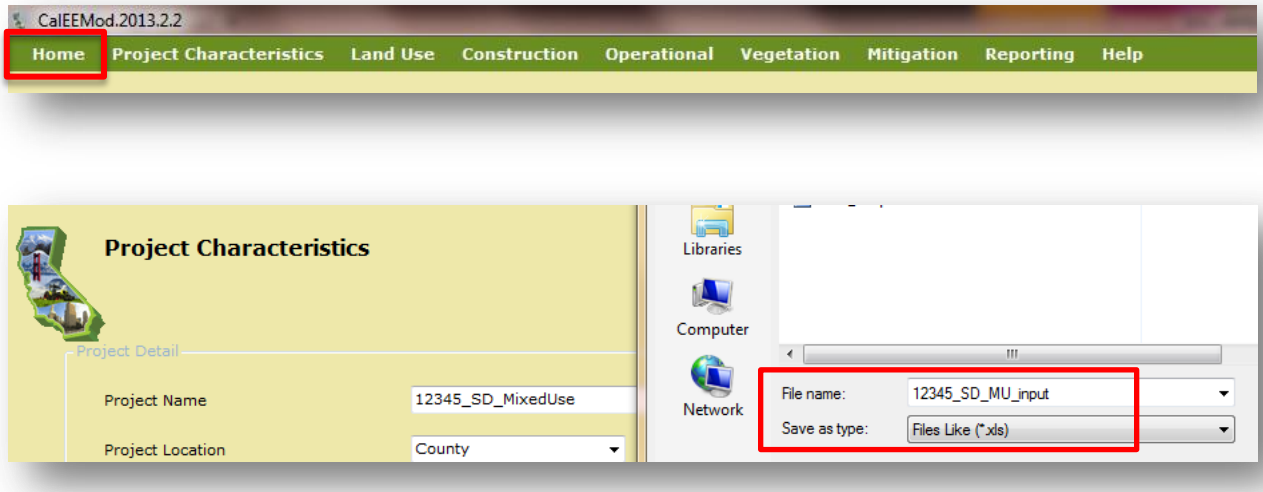
[32] The Project Setting selected is for demonstration purposes only. No analysis has been conducted to determine the Project Setting type for this location.

Mitigation: Traffic, Commute Screen

There are no commute-related measures that are enforceable in the proposed project; therefore, no measures are selected on this screen.

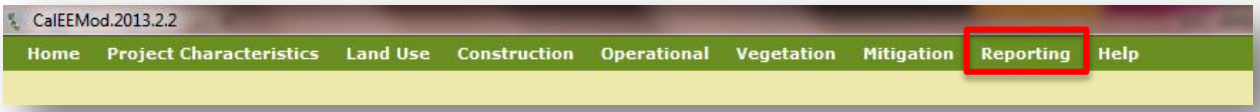


Under the Home tab, select “Save As” and save the input file as “12345_SD_MU_input.”



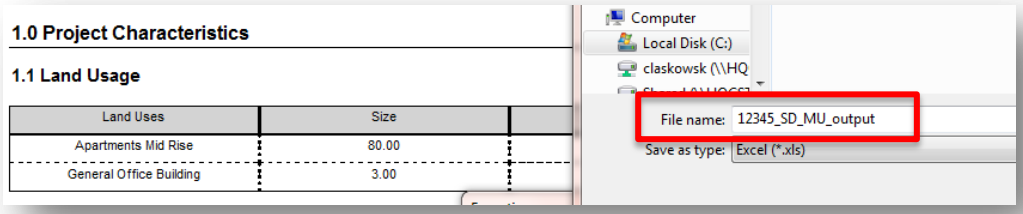
Step 3: Generate a CalEEMod Report

Select “Reporting.”



To run the model, select “Annual” and click on “Recalculate All Emissions and Run Report.” **Allow the program several minutes to run.**

Export the output as an Excel file named “12345_SD_MU_output.”



The output will include unmitigated annual VMT and mitigated annual VMT totals under Trip Summary Information, which will be used in the next steps.

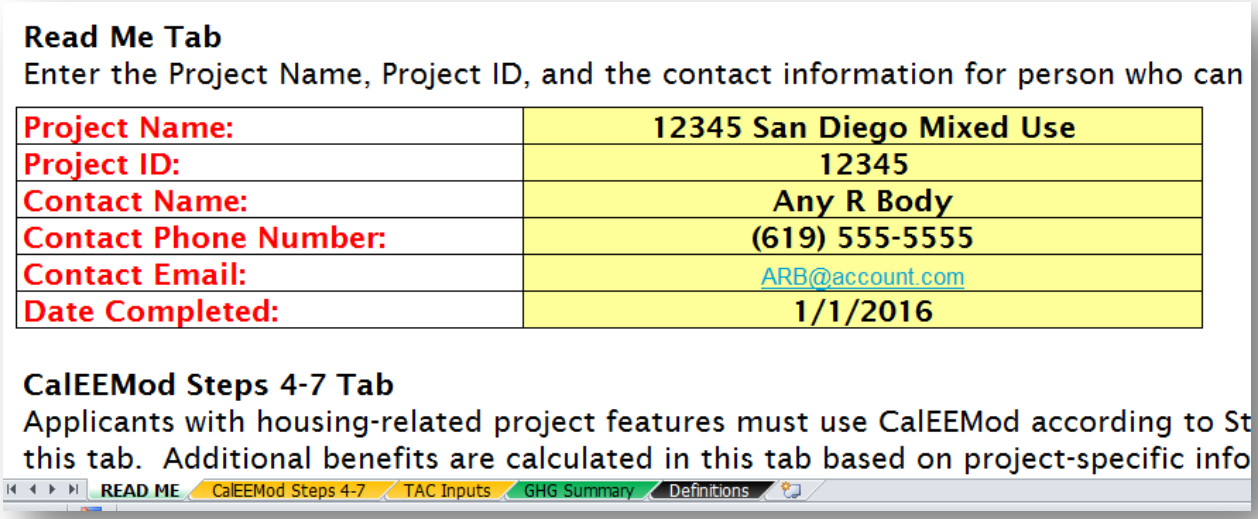
4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Apartments Mid Rise	527.20	572.80	485.60	1,506,948	1,293,591
General Office Building	33.03	7.11	2.94	59,812	51,344
Total	560.23	579.91	488.54	1,566,760	1,344,935

Step 4—7

For Steps 4 through 7, use the Excel-based calculator. The CalEEMod mitigated and unmitigated VMT and other project features will be used as inputs to the calculator.

The **Read Me** tab contains important instructions and basic project information must be inputted here.



Read Me Tab

Enter the Project Name, Project ID, and the contact information for person who can

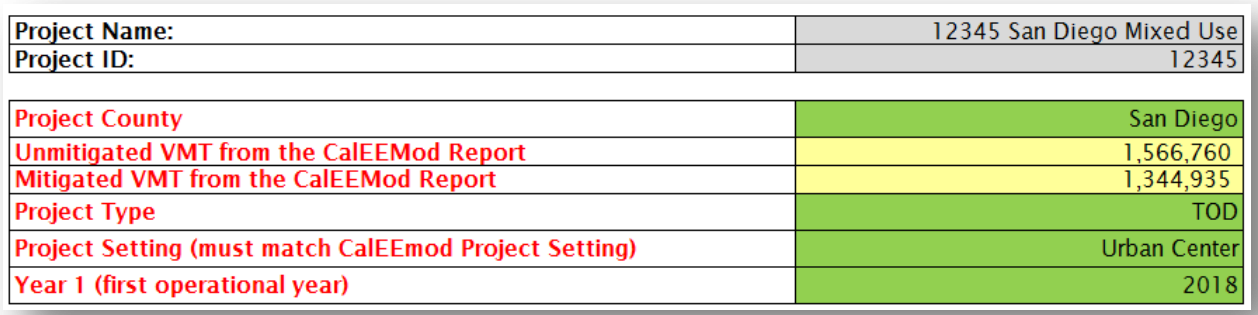
Project Name:	12345 San Diego Mixed Use
Project ID:	12345
Contact Name:	Any R Body
Contact Phone Number:	(619) 555-5555
Contact Email:	ARB@account.com
Date Completed:	1/1/2016

CalEEMod Steps 4-7 Tab

Applicants with housing-related project features must use CalEEMod according to St
this tab. Additional benefits are calculated in this tab based on project-specific info

READ ME | CalEEMod Steps 4-7 | TAC Inputs | GHG Summary | Definitions

Proceed to the **CalEEMod Steps 4-7** tab and enter the basic project information in the green and yellow cells. The information entered must match the inputs (County, Project Type, Project Setting, and Year 1) and outputs (Unmitigated VMT and Mitigated VMT) from CalEEMod.



Project Name:	12345 San Diego Mixed Use
Project ID:	12345
Project County	San Diego
Unmitigated VMT from the CalEEMod Report	1,566,760
Mitigated VMT from the CalEEMod Report	1,344,935
Project Type	TOD
Project Setting (must match CalEEmod Project Setting)	Urban Center
Year 1 (first operational year)	2018

Step 4: ICP/RIPA Adjustment

Select whether LUT-5 was applied in CalEEMod. Based on this answer and the project type, the calculator automatically calculates the Adjustment, if applicable. No adjustment is needed for this project.

Step 4: ICP/RIPA Adjustment	0	VMT
Did you apply LUT-5 in CalEEMod (Increase Transit Accessibility)?		No

Step 5: Calculate Additional Benefits

LUT-1 and LUT-4 apply to the project. Applicant should enter the number of dwelling units per acre for the Project as “32” and the distance to CBD as “0.1” (see below). No other fields should be modified as the other measures are not applicable to the project.

Step 5: Calculate Additional Benefits		
A. LUT-1: Increase Density	22.47	%
Number of dwelling units per acre for the Project If N/A, leave blank or enter "0"	32.00	
B. LUT-9: Improve Walkabililty Design	0.00	%
Number of Intersections per square mile for the Project Area If N/A, leave blank or enter "0"		
C. LUT-4: Increase Destination Accessibility	19.83	%
Distance to CBD (miles)[1] If N/A, leave blank or enter "12"	0.10	
D. SDT-2: Provide Traffic Calming Measures	0	%
Yes/No	No	
E. TRT-4(residents): Transit Subsidy for Residents	0.00	%
Subsidy per eligible resident per Year If N/A, leave blank or select "$0 to $273.74"	$0 to $273.74	
Percent of residents eligible for the subsidy (0-100)		
Number of years the subsidy is funded (0-30)		

Step 6: Calculate the CalEEMod Annual VMT Reductions

This Step is automated. The calculator determines the annual VMT reductions.

Step 6: Calculate the CalEEMod Annual VMT Reductions		
Additional % VMT Reductions (A+B+C+D+E from Step 5)	42.31	%
Additional VMT Reductions	662,849.43	VMT
Total Annual VMT Reductions	884,674.43	VMT
Percent VMT Reduction	56%	%
Maximum Potential Annual Reductions	40%	VMT
Annual CalEEMod VMT Reductions	**626,704.00**	**VMT**

Step 7: Calculate the Total CalEEMod GHG Reductions

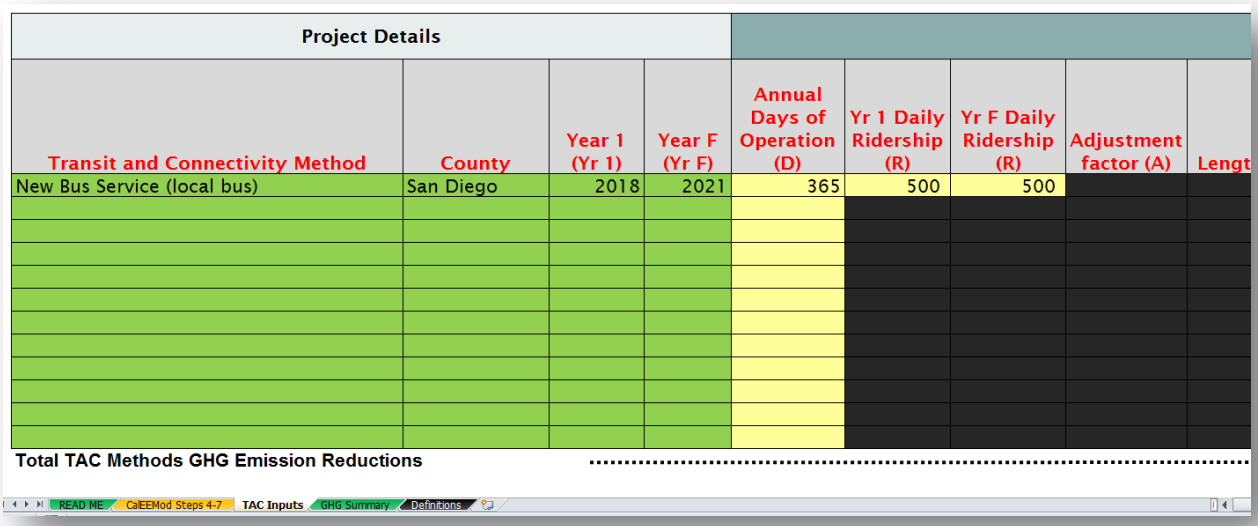
The calculator estimates the Total CalEEMod GHG reductions.

Step 7: Calculate the Total CalEEMod GHG Emission Reductions		
CalEEMod GHG Emission Reductions (Yr 1)	320.27	MT CO_2e
CalEEMod GHG Emission Reductions (Yr F)	197.23	MT CO_2e
Total CalEEMod GHG Emission Reductions	**7,762.50**	MT CO_2e

New Bus Service

To determine the Total GHG Emission Reductions from the new bus service, the applicant must use the **TAC Methods** tab in the calculator.

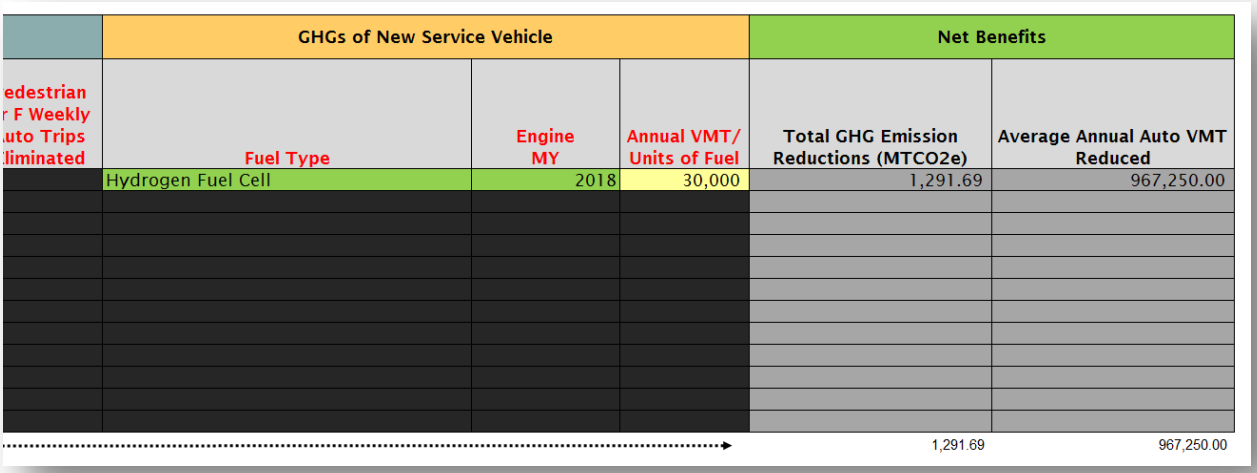
Go to the **TAC Inputs** tab and enter "New Bus Service (local bus)"; the fields that need to be inputted will turn yellow or green. Enter the following information according to the project's features: County, Year 1, Year F, Annual Days of Operation, Yr 1 Daily Ridership, and Yr F Daily Ridership (equal to Yr 1 Daily Ridership unless more detailed project information is available). The proposed project consists of two hydrogen-fuel buses that would each operate 2018-2021; therefore, the information for both buses may be entered in a single row. If there were any differences, such as a different Year 1 or fuel type, each bus would be entered on a separate line. The information, such as ridership and VMT, would be specific to the new or expanded service within each row.



Project Details								
Transit and Connectivity Method	County	Year 1 (Yr 1)	Year F (Yr F)	Annual Days of Operation (D)	Yr 1 Daily Ridership (R)	Yr F Daily Ridership (R)	Adjustment factor (A)	Lengt
New Bus Service (local bus)	San Diego	2018	2021	365	500	500		
Total TAC Methods GHG Emission Reductions								

READ ME | CalEEMod Steps 4-7 | TAC Inputs | GHG Summary | Definitions

Scroll to the right to enter additional information: Fuel Type of the new bus service, Engine Model Year, and Annual VMT of the new bus service. The calculator will automatically provide the Total GHG Emission Reductions and Average Annual Auto VMT reductions.



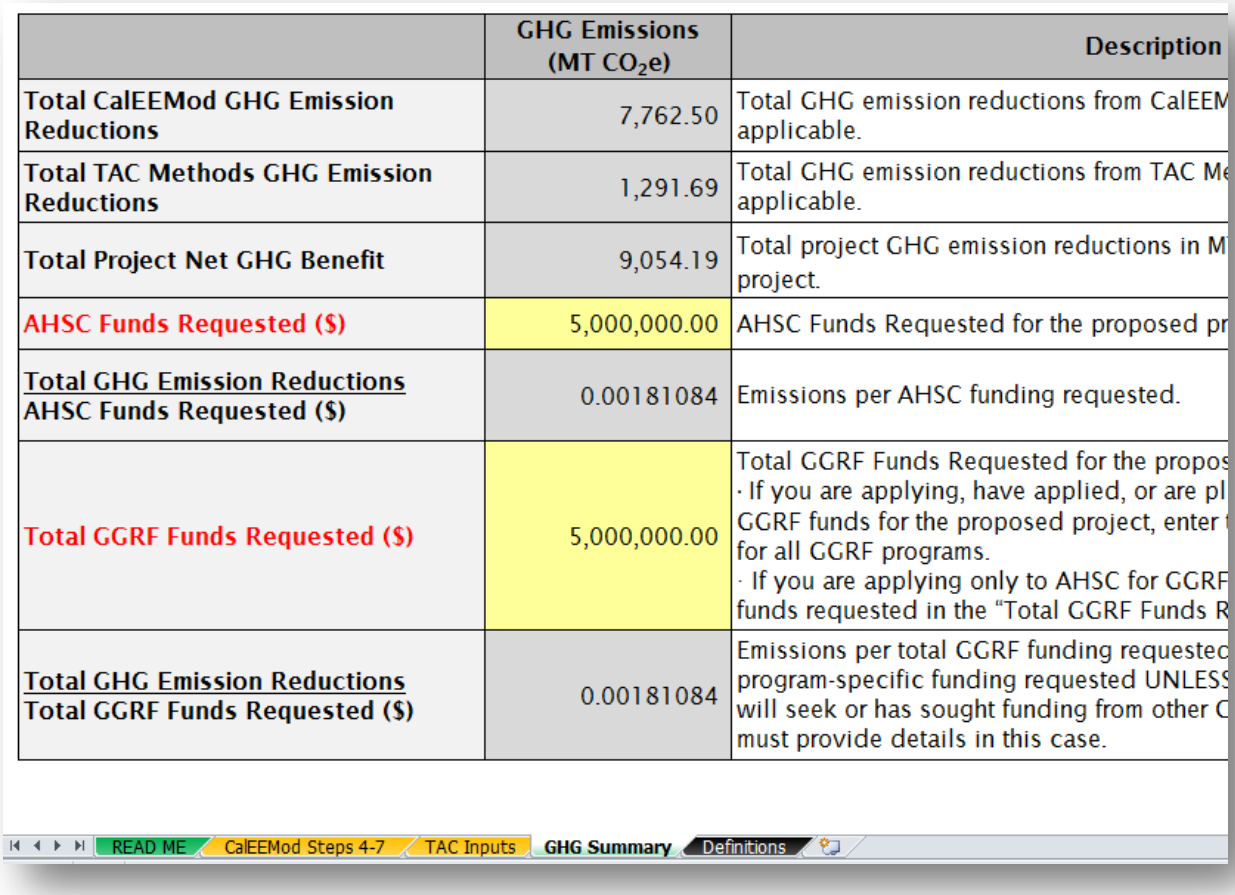
edestrian F Weekly uto Trips liminated	GHGs of New Service Vehicle			Net Benefits	
	Fuel Type	Engine MY	Annual VMT/ Units of Fuel	Total GHG Emission Reductions (MTCO2e)	Average Annual Auto VMT Reduced
	Hydrogen Fuel Cell	2018	30,000	1,291.69	967,250.00
				1,291.69	967,250.00

Information for Documentation

The applicant should proceed to the **GHG Summary** tab and enter the Total AHSC Funds Requested and the Total GGRF Funds Requested to determine the Total GHG Emission Reductions per AHSC and GGRF Funds Requested, which are required documentation components.

Total GHG Emission Reductions are automatically calculated from the **CalEEMod Steps 4—7** tab and **TAC Inputs** tab.

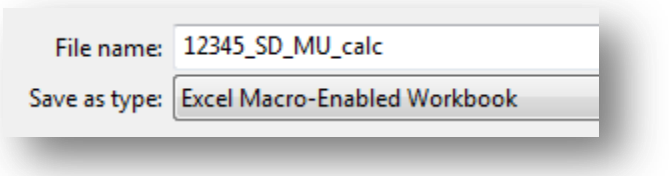
The AHSC funds requested may equal the Total GGRF funds requested if the applicant has not and does not plan to request funds for the same project and phase from other GGRF programs. In this case, applicants should enter the same dollar amount into both fields.



	GHG Emissions ($MT CO_2e$)	Description
Total CalEEMod GHG Emission Reductions	7,762.50	Total GHG emission reductions from CalEEM applicable.
Total TAC Methods GHG Emission Reductions	1,291.69	Total GHG emission reductions from TAC Me applicable.
Total Project Net GHG Benefit	9,054.19	Total project GHG emission reductions in M project.
AHSC Funds Requested ($)	5,000,000.00	AHSC Funds Requested for the proposed pr
Total GHG Emission Reductions / AHSC Funds Requested ($)	0.00181084	Emissions per AHSC funding requested.
Total GGRF Funds Requested ($)	5,000,000.00	Total GGRF Funds Requested for the propos · If you are applying, have applied, or are pl GGRF funds for the proposed project, enter for all GGRF programs. · If you are applying only to AHSC for GGRF funds requested in the "Total GGRF Funds R
Total GHG Emission Reductions / Total GGRF Funds Requested ($)	0.00181084	Emissions per total GGRF funding requested program-specific funding requested UNLESS will seek or has sought funding from other C must provide details in this case.

READ ME | CalEEMod Steps 4-7 | TAC Inputs | GHG Summary | Definitions

Save the file as instructed on the **Read Me** tab:



Applicants must submit the completed calculator along with other required documentation to SGC and ARB. Refer to Section D of the quantification methodology and the AHSC Program Application for additional requirements.

Appendix B. Land Use Subtypes and Default Parking Rates

Residential Land Use Subtypes and Parking Rates

Applicants must select the residential land use subtype that most accurately reflects the type of development proposed in the application. For example, a senior housing project would most appropriately be classified as "Retirement Community." Table B-1 provides descriptions for the most common residential land use types. Definitions were derived using the CalEEmod User's Guide. For applicants using PDT-1, default ITE parking rates are also provided in Table B-1 and were derived from ITE Parking Generation, 4th Edition, Average Peak Period Parking Demand and the percent reduction should be calculated using only the residential land use information.

Table B-1. Residential Land Use Subtype Descriptions and Default Parking Rates

Residential Land Use Subtype	Description	ITE Default Parking Rates (spaces per dwelling unit)
Single Family Housing	All single-family detached homes on individual lots.	1.83
Apartments High Rise	High-rise apartments are units located in rental buildings that have more than 10 levels and most likely have one or more elevators.	1.37
Apartments Low Rise	Low-rise apartments are units located in rental buildings that have 1-2 levels.	1.23
Apartments Mid Rise	Mid-rise apartments in rental buildings that have between 3 and 10 levels.	Apartments with three or four stories should use 1.23; apartments with five to 10 stories should use 1.37
Condo/Townhouse	Ownership units that have at least one other owned unit within the same building structure.	1.38
Condo/Townhouse High Rise	Ownership units that have three or more levels.	1.38
Retirement Community	Communities that provide multiple elements of senior adult living.	0.59

Non-Residential Land Use Subtypes and Parking Rates

For the non-residential component of mixed-use projects, the applicant must use a land use type of "Commercial" and a land use subtype of "General Office Building." PDT-1 only applies to residential land uses; therfore, no parking rate information is needed for non-residenical land use subtypes.

Appendix C. Project Setting Types

Applicants should use the descriptions in the table below, as defined in the CAPCOA Quantification Report, to determine the appropriate Project Setting. The descriptions provide the typical characteristics of the Project Setting types used by CAPCOA and in CalEEMod for determining the effectiveness of strategies for reducing VMT. The maximum reduction values are derived from the percentage difference in per capita VMT compared against a statewide average and reflect the highest reduction levels justified by the literature as reviewed for the CAPCOA Quantification Report. TOD and ICP Project Type applicants must provide a narrative explaining the justification for the Project Setting used. RIPA Project Type applicants are required to use Low Density Suburban and therefore do not have to submit a narrative.

CalEEMod Project Setting Types	CAPCOA GHG Location Types	CAPCOA Location Description	Maximum Reductions (Cap on % VMT reduction)
Urban	Urban	A project located within the central city and may be characterized by multi-family housing, located near office and retail. The urban locations listed above have the following characteristics: o Location relative to the regional core: these locations are within the CBD or less than five miles from the CBD (downtown Oakland and downtown San Francisco). o Ratio or relationship between jobs and housing: jobs-rich (jobs/housing ratio greater than 1.5) o Density character • typical building heights in stories: six stories or (much) higher • typical street pattern: grid • typical setbacks: minimal • parking supply: constrained on and off street • parking prices: high to the highest in the region o Transit availability: high quality rail service and/or comprehensive bus service at 10 minute headways or less in peak hours Examples: San Francisco, Downtown Oakland	75%

CalEEMod Project Setting Types	CAPCOA GHG Location Types	CAPCOA Location Description	Maximum Reductions (Cap on % VMT reduction)
Urban Center	Compact Infill	A project located on an existing site within the central city or inner-ring suburb with high-frequency transit service. Examples may be community redevelopment areas, reusing abandoned sites, intensification of land use at established transit stations, or converting underutilized or older industrial buildings. The compact infill locations listed above have the following characteristics: o Location relative to the regional core: these locations are typically 5 to 15 miles outside a regional CBD o Ratio or relationship between jobs and housing: balanced (jobs/housing ratio ranging from 0.9 to 1.2) o Density character • typical building heights in stories: two to four stories • typical street pattern: grid • typical setbacks: 0 to 20 feet • parking supply: constrained • parking prices: low to moderate o Transit availability: rail service within two miles, or bus service at 15 minute peak headways or less Examples: Fairfax (LA), Albany	40%

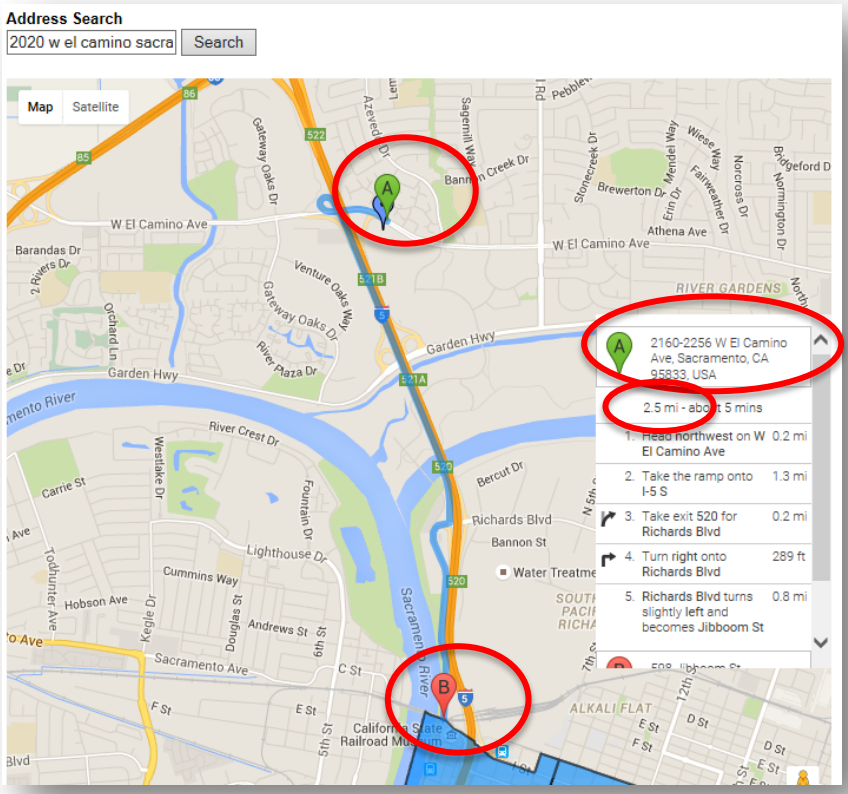
CalEEMod Project Setting Types	CAPCOA GHG Location Types	CAPCOA Location Description	Maximum Reductions (Cap on % VMT reduction)
Suburban Center	Suburban Center	A project typically involving a cluster of multi-use development within dispersed, low-density, automobile dependent land use patterns (a suburb). The center may be an historic downtown of a smaller community that has become surrounded by its region's suburban growth pattern in the latter half of the 20th Century. The suburban center locations listed above have the following characteristics: o Location relative to the regional core: these locations are typically 20 miles or more from a regional CBD o Ratio or relationship between jobs and housing: balanced o Density character • typical building heights in stories: two stories • typical street pattern: grid • typical setbacks: 0 to 20 feet • parking supply: somewhat constrained on street; typically ample off-street • parking prices: low (if priced at all) o Transit availability: bus service at 20-30 minute headways and/or a commuter rail station Examples: Downtown San Rafael, San Mateo	20%

CalEEMod Project Setting Types	CAPCOA GHG Location Types	CAPCOA Location Description	Maximum Reductions (Cap on % VMT reduction)
Low Density Suburban	Suburban	A project characterized by dispersed, low-density, single-use, automobile dependent land use patterns, usually outside of the central city (a suburb). Suburbs typically have the following characteristics: o Location relative to the regional core: these locations are typically 20 miles or more from a regional CBD o Ratio or relationship between jobs and housing: jobs poor o Density character • typical building heights in stories: one to two stories • typical street pattern: curvilinear (cul-de-sac based) • typical setbacks: parking is generally placed between the street and office or retail buildings; large-lot residential is common • parking supply: ample, largely surface lot-based • parking prices: none o Transit availability: limited bus service, with peak headways 30 minutes or more Examples: Areas that don't fit into one of the other definitions	15%

Appendix D. Distance to Central Business District

The distance from a project to a central business district (CBD) is used in the Quantification Method Using CalEEMod for LUT-4 (calculated in Step 5) and as one of the criteria in selecting a Project Setting type (see Appendix C). Central Business District (CBD) is defined as census tract (using 2011 census data) with at least 5,000 jobs per square mile. To determine the distance to CBD for a project, applicants will use the following webpage, which includes instructions: http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/kml/jobcentermap.html.

Applicants are instructed to submit a screenshot of the map that includes the "from" and "to" pins, the project address, and the project distance to CBD. An example screenshot with the required elements circled is shown below. In this example, the distance from the project to CBD is 2.5 miles. This value would be used in Equation 5 (Step 5 of Section B), if applicable and for determining the appropriate Project Setting in Appendix C.



Appendix E. Equations Supporting the AHSC GHG Calculator Tool

ARB developed the Excel-based AHSC GHG calculator tool to automate many of the portions of this quantification methodology. This appendix provides the equations used in the AHSC GHG calculator.

CalEEMod Methods—Additional Benefits and GHG Calculations

Calculations supporting Section B steps 4 through 7 are provided below.

Step 4: ICP/RIPA Adjustment

The data supporting transit accessibility (LUT-5) in CalEEMod are based on high-quality transit service. Since ICP and RIPA projects by definition per AHSC Guidelines do not include high-quality transit, an adjustment is needed for these projects. Therefore, this Step only applies to ICP and RIPA projects that are taking credit for LUT-5 in CalEEMod.

For ICP/RIPA projects implementing LUT-5[33]:

$$ICP/RIPA\ Adjustment = 0.025 * Unmitigated\ VMT \quad \textbf{(Eq. 1)}$$

[33] Based on documentation in the CAPCOA Quantification Report for TST-4: Increase Transit Frequency/Speed

Step 5: Calculate Additional Benefits

The following equations support these measures:

A. LUT-1: Increase Density
B. LUT-9: Improve Walkability Design
C. LUT-4: Improve Destination Accessibility
D. SDT-2: Provide Traffic Calming Measures
E. TRT-4(residents): Transit Subsidy for Residents. Note: The CalEEMod Transit Subsidy is applicable to non-residential land use types (for employees). This equation has been provided to apply transit subsidies to residents.

A. Increase Density (LUT-1)

$$\%\ Density\ Increase = 100 * \left[\frac{\boldsymbol{Project\ dwelling\ units\ per\ acre} - 7.6}{7.6}\right] \quad \textbf{(Eq. 2)}$$

$$\%\ VMT\ Reduction = 0.07 * \%\ Density\ Increase \quad \textbf{(Eq. 3)}$$

or 30% (whichever is lower)

B. Improve Walkability Design (LUT-9)

$$\%\ VMT\ Reduction = 100 * 0.12 * \left[\frac{\#\ \boldsymbol{of\ Intersections\ per\ Square\ Mile} - 36}{36}\right] \quad \textbf{(Eq. 4)}$$

or 21.3% (whichever is lower)

C. Increase Destination Accessibility (LUT-4)

$$\%\ Distance\ Decrease = 100 * \left[\frac{\boldsymbol{Distance\ to\ CBD} - 12}{12}\right] \quad \textbf{(Eq. 5)}$$

$$\%\ VMT\ Reduction = -0.20 * \%\ Distance\ Decrease \quad \textbf{(Eq. 6)}$$

or 20% (whichever is lower)

Refer to Appendix D for instructions on estimating Distance to CBD.

D. Provide Traffic Calming Measures (SDT-2)

$$\%\ VMT\ Reduction = 1\% \quad \textbf{(Eq. 7)}$$

E. Transit Subsidy for Residents (TRT-4(residents))

$$\%\ VMT\ Reduction = A * B * \left(\frac{C}{30}\right) \quad \textbf{(Eq. 8)}$$

Where,
A is the percent VMT reduction per eligible resident shown in Table E-1.

Table E-1. Adjustment Factor (A) Lookup Table for Eq. 8

Transit Subsidy or Discount per Year per Eligible Resident	A=Percent Reduction in Commute VMT per Eligible Resident		
	Low Density Suburban[34]	Suburban Center[35]	Urban and Urban Center[35]
From $273.75 to $543.84	1.5%	3.4%	6.2%
$543.85 to $1,087.69	3.3%	7.3%	12.9%
$1,087.70 to $2,175.39	7.9%	16.4%	20.0%
$2,175.40 or greater	20.0%	20.0%	20.0%

Note: Subsidies below $273.75 per Eligible Resident per Year may not use this measure.

B is the percent of residents eligible for the subsidized or discounted transit program (i.e., 0-100).

C is the number of years that the subsidy/discount is funded or guaranteed under the proposed project or transit agency program (i.e., 0-30 years).[35]

Example: A project providing a $2,500 per year subsidy to 100% of residents for 3 years would calculate the % VMT reduction as: % VMT reduction = [20% * 100 * (3/30)] = 2%.

[34] Refer to Project Setting designation used from Table 2.
[35] The subsidy/discount may include GGRF and other enforceable commitment funds.

Step 6: Calculate the CalEEMod Annual VMT Reductions

Annual VMT reductions

$$Additional\ \%\ VMT\ Reductions = Eq.3 + \ Eq.4 + Eq.6 + Eq.7 + \ Eq.8 \quad \textbf{(Eq. 9)}$$

$$Additional\ VMT\ Reductions = Unmitigated\ VMT * Additional\ \%\ VMT\ Reductions \quad \textbf{(Eq. 10)}$$

$$Total\ Annual\ VMT\ Reductions = Unmitigated\ VMT - Mitigated\ VMT + Additional\ VMT\ Reductions\ (Eq.10) - ICP/RIPA\ Adjustment\ (Eq.1) \quad \textbf{(Eq. 11)}$$

Percent VMT Reductions for the project

$$Percent\ VMT\ Reduction = \frac{Total\ Annual\ VMT\ Reductions}{Unmitigated\ VMT} \quad \textbf{(Eq. 12)}$$

The project Maximum Potential Reductions according to the Project Setting is shown in Table E-2.

Table E-2. Maximum Potential Reductions by Project Setting Type

CalEEMod Project Setting Types*	Maximum Potential Reductions (Total maximum project VMT reduction)[36]
Low Density Suburban	15%
Suburban Center	20%
Urban Center	40%
Urban	75%

*Listed in order of increasing maximum potential reductions

If the Percent VMT Reduction is greater than the Maximum Potential Reduction for the Project Setting, **Adjust** the Percent VMT Reduction:

$$Adjusted\ Percent\ VMT\ Reduction = Maxiumum\ Potential\ Reduction\ by\ Project\ Setting \quad \textbf{(Eq. 13)}$$

Annual CalEEMod VMT Reductions

$$Annual\ CalEEmod\ VMT\ Reductions = (Adjusted) Percent\ VMT\ Reduction * Unmitigated\ VMT \quad \textbf{(Eq. 14)}$$

[36] As defined in the CAPCOA Quantification Report. The interactions among transportation-related measures are complex and sometimes counter-intuitive. The maximum reduction values are derived from the percentage difference in per capita VMT compared against a statewide average and reflect the highest reduction levels justified by the literature as reviewed for the CAPCOA Quantification Report.

Step 7: Calculate the Total CalEEMod GHG Reductions

CalEEMod GHG Reductions for Year 1 and Year F:

$$CalEEmod\ Reductions\ (Yr\ 1) = \frac{Annual\ CalEEMod\ VMT\ Reductions * AVEF_{Yr\ 1}}{1{,}000{,}000} \quad \textbf{(Eq. 15)}$$

$$CalEEmod\ Reductions\ (Yr\ F) = \frac{Annual\ CalEEMod\ VMT\ Reductions * AVEF_{Yr\ F}}{1{,}000{,}000} \quad \textbf{(Eq. 16)}$$

Where,
AVEF is the Auto Vehicle Emission Factor (grams of CO_2e per mile) by county for Year 1 or Year F. The life of the project is defined as 30 years; therefore, Year F = Year 1 + 30. Emission factor lookup tables are provided in the links in Table E-5. Appendix F provides the methodology for the emission factor development.

Total CalEEMod GHG Reductions:

$$CalEEmod\ Reductions = \frac{CalEEMod\ Reductions_{Yr\ 1} + CalEEMod\ Reductions_{Yr\ F}}{2} * 30 \quad \textbf{(Eq. 17)}$$

TAC Methods—Additional Benefits and GHG Calculations

Calculations supporting the TAC Methods are provided below.

New/Expanded Bus, Train, Shuttle, or Vanpool Service

Annual VMT of Displaced Autos from New Service

$$Annual\ Auto\ VMT\ Reduced\ from\ New\ Service = [(\boldsymbol{D}) * (\boldsymbol{R}) * (\boldsymbol{A})] * [(\boldsymbol{L}) - (\boldsymbol{AA}) * (\boldsymbol{LL})] \quad \textbf{(Eq. 18)}$$

Where,

Factor	Description	Default Values			
		Bus	**Train[37]**	**Shuttle**	**Vanpool**
D	Days of operation per year of new service	260 (weekday service) 365 (daily service)	User-defined	260 (weekday service) 365 (daily service)	260 (weekday service) 365 (daily service)
R	Daily ridership of new service	Expected daily ridership based on project data. For example, one bus rider commuting round trip per day is two bus trips per day.*			
A	Adjustment factor to account for transit dependency	0.5 (local bus) 0.83 (long distance commuter)	User-defined	0.83	0.83
L	Length of average auto trip reduced	10.8 miles[38]	User-defined	16	35
AA	Adjustment factor to account for auto trips used to access new service	0.1 (local bus) 0.8 (long distance commuter)	User-defined	0.75	0.75
LL	Length of average trip for auto access to transit	2 miles (local bus) 5 miles (long distance commuter)	User-defined	5	5

*If the Ridership will vary over the life of the project, the applicant must calculate the Annual Auto VMT reduced for the first and last year of the project operation.

[37] Default values for new Train service are not available due to high variability. Applicants must provide these values and document how the values were derived.
[38] Average statewide trip length, per CalEEMod.

Auto GHG Reductions for Year 1 and Year F of the New Service

$$New\ Service\ Auto\ Reductions\ (Yr\ 1) = \frac{(Annual\ VMT\ Reduced_{Yr\ 1}) * AVEF_{Yr\ 1}}{1{,}000{,}000} \quad \textbf{(Eq. 19)}$$

$$New\ Service\ Auto\ Reductions\ (Yr\ F) = \frac{(Annual\ VMT\ Reduced_{Yr\ F}) * AVEF_{Yr\ F}}{1{,}000{,}000} \quad \textbf{(Eq. 20)}$$

Where,
AVEF is the Auto Vehicle Emission Factor (grams of CO_2e per mile), found in the Lookup table links in Table E-5.

New Service Auto GHG Useful Life (UL) Reductions

$$New\ Service\ Auto\ Reductions = \frac{New\ Service\ Auto\ Reductions_{Yr1} + New\ Service\ Auto\ Reductions_{YrF}}{2} * UL \quad \textbf{(Eq. 21)}$$

Where,
UL is Useful Life, as defined as the number of years the project has enforceable committed funds for operation of the new/expanded service.

New Service GHG Emissions for Year 1 and Year F

$$New\ Service\ Emissions\ (Yr\ 1) = \frac{(NSVMT_{Yr\ 1}) * NSEF_{Yr\ 1}}{1{,}000{,}000} \quad \textbf{(Eq. 22)}$$

$$New\ Service\ Emissions\ (Yr\ F) = \frac{(NSVMT_{Yr\ F}) * NSEF_{Yr\ F}}{1{,}000{,}000} \quad \textbf{(Eq. 23)}$$

Where,
NSVMT is the annual VMT for the New Service and **NSEF** is the Emission Factor (grams of CO_2e per mile) for the New Service, according to Table E-5 or E-6.

New Service GHG Useful Life (UL) Emissions

$$New\ Service\ UL\ Emissions = \frac{New\ Service\ Emissions_{Yr1} + New\ Service\ Emissions_{YrF}}{2} * UL \quad \textbf{(Eq. 24)}$$

New Service Total GHG Reductions

$$New\ Service\ Total\ GHG\ Reductions = New\ Service\ Auto\ UL\ Reductions - New\ Service\ UL\ Emissions \quad \textbf{(Eq. 25)}$$

New Ferry Service

Annual VMT of Displaced Autos from New Service

$$Annual\ Auto\ VMT\ Reduced\ from\ New\ Service = [(\boldsymbol{D}) * (\boldsymbol{R}) * (\boldsymbol{A})] * [(\boldsymbol{L}) - (\boldsymbol{AA}) * (\boldsymbol{LL})] \quad \textbf{(Eq. 26)}$$

Where,

Factor	Description
D	Days of operation per year of new service
R	Daily ridership of new service
A	Adjustment factor to account for transit dependency
L	Length of average auto trip reduced
AA	Adjustment factor to account for auto trips used to access new service
LL	Length of average trip for auto access to transit

*If the Ridership will vary over the life of the project, the applicant must calculate the Annual Auto VMT reduced for the first and last year of the project operation. Applicant must provide these values and documentation supporting the values.

Auto GHG Reductions for Year 1 and Year F of the New Service

$$New\ Service\ Auto\ Reductions\ (Yr\ 1) = \frac{(Annual\ VMT\ Reduced_{Yr\ 1}) * AVEF_{Yr\ 1}}{1{,}000{,}000} \quad \textbf{(Eq. 27)}$$

$$New\ Service\ Auto\ Reductions\ (Yr\ F) = \frac{(Annual\ VMT\ Reduced_{Yr\ F}) * AVEF_{Yr\ F}}{1{,}000{,}000} \quad \textbf{(Eq. 28)}$$

Where,
AVEF is the Auto Vehicle Emission Factor (grams of CO_2e per mile), found in the Lookup tables links in Table E-5.

New Service Auto GHG Useful Life (UL) Reductions

$$New\ Service\ Auto\ Reductions = \frac{New\ Service\ Auto\ Reductions_{Yr1} + New\ Service\ Auto\ Reductions_{YrF}}{2} * UL \quad \textbf{(Eq. 29)}$$

Where,
UL is Useful Life, as defined as the number of years the project has enforceable committed funds for operation of the new/expanded service.

New Service GHG Emissions for Year 1 and Year F

$$New\ Service\ Emissions\ (Yr\ 1) = \frac{(Fuel\ Consumption_{Yr\ 1}) * FEF}{1{,}000{,}000} \quad \textbf{(Eq. 30)}$$

$$New\ Service\ Emissions\ (Yr\ F) = \frac{(Fuel\ Consumption_{Yr\ F}) * FEF}{1{,}000{,}000} \quad \textbf{(Eq. 31)}$$

Where,
Fuel Consumption is the amount of fuel consumed by the Ferry per year in Year 1 or Year F;
FEF is the carbon intensity Emission Factor (grams of CO_2e per unit of fuel) for the Ferry, according the type of fuel consumed:

Fuel Type (units)	FEF (gCO_2e/unit of fuel)
CNG (scf)	78
Diesel (gal)	13,818
Electric/BEV or PHEV (KWh)	379
Hydrogen Fuel Cell (kg)	12,678
Hydrogen Fuel Cell (SB 1505) (kg)	10,466
LNG (gal)	6,824

Emission factors calculated by ARB

New Service GHG Useful Life (UL) Emissions

$$New\ Service\ UL\ Emissions = \frac{New\ Service\ Emissions_{Yr\ 1} + New\ Service\ Emissions_{Yr\ F}}{2} * UL \quad \textbf{(Eq. 32)}$$

New Service Total GHG Reductions

$$New\ Service\ Total\ GHG\ Reductions = New\ Service\ Auto\ UL\ Reductions - New\ Service\ UL\ Emissions \quad \textbf{(Eq. 33)}$$

Bicycle Paths or Lanes

Annual VMT Reductions of Displaced Autos from Bicycle Paths/Lanes

$$Bike\ Lane\ Auto\ VMT\ Reduced = (\boldsymbol{D}) * (\boldsymbol{ADT}) * (\boldsymbol{A} + \boldsymbol{C}) * (\boldsymbol{L}) \quad \textbf{(Eq. 34)}$$

Where,

Factor	Description	Default Values
D	Days of use per year of new service	200
ADT*	Annual Average Daily Traffic (two-way traffic volume in trips/day on parallel road. Use applicable value from project data (Maximum = 30,000)	Use project-specific data.
A	Adjustment factor to account for bike use	Use applicable value from Table E-3
C	Activity Center Credit near project	Use applicable value from Table E-4
L	Length of bicycle trip	1.8 miles per trip in one direction

*If the ADT will vary over the life of the project, the applicant must calculate the Auto VMT reduced for the first and last year of the project operation. Applicant must provide these values and documentation supporting the values.

Table E-3. Adjustment Factor (A) Lookup Table for Eq. 34

Average Daily Traffic (ADT)	Length of Bike Project (one direction)	A (for cities >250,000 and non-university towns <250,000)	A (for university towns with population <250,000)
ADT ≤ 12,000 vehicles per day	≤ 1 mile	.0019	.0104
	> 1 & ≤ 2 miles	.0029	.0155
	> 2 miles	.0038	.0207
12,000 < ADT ≤ 24,000 vehicles per day	≤ 1 mile	.0014	.0073
	> 1 & ≤ 2 miles	.0020	.0109
	> 2 miles	.0027	.0145
24,000 < ADT ≤ 30,000 vehicles per day Maximum is 30,000	≤ 1 mile	.0010	.0052
	> 1 & ≤ 2 miles	.0014	.0078
	> 2 miles	.0019	.0104

Table E-4. Activity Center Credit (C) Lookup Table for Eq. 34

Count your Activity Centers. If there are…	Within 1/2 mile of Project Area	Within 1/4 mile of Project Area
3	.0005	.001
More than 3 but fewer than 7	.0010	.002
7 or more	.0015	.003

Activity Center examples: Bank, church, hospital or HMO, light rail station (park & ride), office park, post office, public library, shopping area or grocery store, university, or junior college. These metrics should be evaluated for the project location site and surrounding area which can extend a distance from the housing development not to exceed one-half (½) mile.

Auto GHG Reductions for Year 1 and Year F of the Bike Lane

$$Bike\ Lane\ Auto\ Reductions\ (Yr\ 1) = \frac{Bike\ Lane\ Auto\ VMT\ Reduced_{Yr\ 1} * AVEF_{Yr\ 1}}{1{,}000{,}000} \quad \textbf{(Eq. 35)}$$

$$Bike\ Lane\ Auto\ Reductions\ (Yr\ F) = \frac{Bike\ Lane\ Auto\ VMT\ Reduced_{Yr\ F} * AVEF_{Yr\ F}}{1{,}000{,}000} \quad \textbf{(Eq. 36)}$$

Where,
AVEF is the Auto Vehicle Emission Factor (grams of CO_2e per mile), found in the Lookup table links in Table E-5.

Bike Lane GHG Useful Life (UL) Reductions

$$Bike\ Lane\ UL\ Reductions = \frac{Bike\ Lane\ Auto\ Reductions_{Yr1} + Bike\ Lane\ Auto\ Reductions_{YrF}}{2} * UL \quad \textbf{(Eq. 37)}$$

Where,
UL is Useful Life, which is 20 years for Class 1 and 15 years for Class 2 bicycle lanes.

Pedestrian Facilities

Annual VMT Reductions of Displaced Autos

$$Ped\ Auto\ VMT\ Reduced\ =\ (\boldsymbol{W}) * (\boldsymbol{T}) * (\boldsymbol{L}) \quad \textbf{(Eq. 38)}$$

Where,

Factor	Description	Default Values
W	Weeks of operation per year	52
T*	Auto trips eliminated	Use: Total one-way trips per week based on project data
L	Length of auto trip eliminated	Use: Average distance to adjacent activity center (Default: 1.0)

*If the auto trips eliminated will vary over the life of the project, the applicant must calculate the Auto VMT reduced for the first and last year of the project operation. Applicant must provide these values and documentation supporting the values.

Auto GHG Reductions for Year 1 and Year F of the Pedestrian Facilities

$$Ped\ Auto\ Reductions\ (Yr\ 1) = \frac{Ped\ Auto\ VMT\ Reduced_{Yr\ 1} * AVEF_{Yr\ 1}}{1{,}000{,}000} \quad \textbf{(Eq. 39)}$$

$$Ped\ Auto\ Reductions\ (Yr\ F) = \frac{Ped\ Auto\ VMT\ Reduced_{Yr\ F} * AVEF_{Yr\ F}}{1{,}000{,}000} \quad \textbf{(Eq. 40)}$$

Where,
AVEF is the Auto Vehicle Emission Factor (grams of CO_2e per mile), found in the Lookup table links in Table E-5.

Pedestrian Facilities GHG Useful Life (UL) Reductions

$$Ped\ UL\ Reductions = \frac{Ped\ Auto\ Reductions_{Yr1}\ + Ped\ Auto\ Reductions_{YrF}}{2} * UL \quad \textbf{(Eq. 41)}$$

Where,
UL is Useful Life, which is defined as 15 years.

Emission Factor Lookup Tables

GGRF programs estimate transportation-related emissions using a "Well-to-Wheels" approach, which consists of emissions resulting from the production and distribution of different fuel types, including hydrogen and electricity, and any associated exhaust emissions. AHSC Program applicants use project-specific data to calculate new or avoided vehicle miles traveled (VMT) and VMT is converted to greenhouse gas emissions using Well-to-Wheels emission factors embedded in the AHSC GHG calculator tool. Table E-5 provides links to the relevant Lookup tables used in the AHSC GHG calculator. A detailed methodology of how the emission factors were developed is provided in Appendix F.

Table E-5. Auto, Bus, Van, and Shuttle Emission Factor Tables

Emission Factor	Link to Lookup Tables	How to use Lookup Tables
Auto Vehicle Emission Factors	http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/ef_avef_final.pdf	Look up the county and year for both Year 1 and Year F
Bus Emission Factors	http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/ef_bus_final.pdf	Look up Year 1 and the Model Year of the vehicle being added, according to fuel type, for the emission factor for Year 1. Look up Year F and the same Model Year and fuel type, for the emission factor for Year F.
Van/ Shuttle Emission Factors	http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/ef_ldh_busshuttle_final.pdf	Look up Year 1 and the Model Year of the vehicle being added, according to fuel type, for the emission factor for Year 1. Look up Year F and the same Model Year and fuel type, for the emission factor for Year F.

For trains, the same emission factor will be used for both Year 1 and Year F, according to fuel type in Table E-6.

Table E-6. Train Emission Factor Tables

Train Fuel Type	gCO_2e/mile
CNG	21,596
Diesel	25,136
Electric (Heavy Rail)	5,592
Electric (Light Rail)	7,795
Electric (Trolley Bus, Cable Car, Street Car)	8,298
Hydrogen Fuel Cell	13,602
Hydrogen Fuel Cell (SB 1505)	11,229
LNG	23,529

Appendix F. Emission Factors

The emission factors were developed using fuel consumption rates from ARB's Mobile Source Emission Factor Model (EMFAC 2014[39]) and carbon intensity values for different fuel types from ARB's Low Carbon Fuel Standard (LCFS) Program. This approach provides consistency amongst transportation-related GGRF programs and ARB's Low Carbon Fuel Standard (LCFS[40]) Program.

The following sections detail how the emission factors were developed.

Auto Vehicle Emission Factors

Passenger (auto) vehicle emission factors (**AVEF**) were derived using the following steps.

1. Emissions by county for each calendar year from 2016 through 2050 were downloaded from EMFAC 2014 with the following parameters:
    a. Annual Average
    b. EMFAC2011 vehicle categories LDA, LDT1, LDT2, and MDV
    c. Aggregated model year
    d. Aggregated speed
    e. Gasoline fuel

2. The auto fuel consumption rate (**AFCR**, in gallons of gasoline per mile) was calculated using the total gallons of gasoline used by each vehicle category divided by the total mileage by vehicle category by county and year, using the following equation:

$$AFCR = \frac{(Fuel\_Consumption_{LDA} + Fuel\_Consumption_{LDT1} + Fuel\_Consumption_{LDT2} + Fuel\_Consumption_{MDV}) * 1{,}000}{VMT_{LDA} + VMT_{LDT1} + VMT_{LDT2} + VMT_{MDV}}$$

    Where,
    Fuel_Consumption is the total fuel consumption for the vehicle type, in 1,000 gallons per day, from EMFAC 2014, and

    VMT is the total vehicle miles traveled for the vehicle type, in miles per day, from EMFAC 2014.

3. The auto vehicle emission factors (**AVEF**, in grams of CO_2e per mile) were calculated for each year and county by multiplying auto fuel consumption rate the by the Well-to-Wheels carbon content factor for gasoline, which is 11,460.09 g CO_2e per gallon (Table E-1), using the following equation:

$$AVEF = 11{,}460.09 * AFCR$$

[39] http://www.arb.ca.gov/emfac/2014/
[40] http://www.arb.ca.gov/fuels/lcfs/lcfs.htm

Bus and Van/Shuttle Emission Factors

The bus and van/shuttle new service emission factors (NSEF) were derived using a similar method, as follows.

1. The statewide emissions each calendar year from 2016 through 2050 were downloaded from EMFAC 2014 with the following parameters:
    a. Annual Average
    b. EMFAC2011 vehicle categories UBUS for bus and LHD1 for Van/Shuttle
    c. All model years
    d. Aggregated speed
    e. Diesel fuel
2. The new service fuel consumption rate (**NSCR**, in gallons of diesel per mile) was calculated using the total gallons of diesel fuel used by each vehicle category and model year divided by the total mileage by vehicle category and model year, using the following equation:

$$NSCR_{diesel} = \frac{Fuel\_Consumption_{(UBUS\ \ \boldsymbol{OR}\ \ LDH1)} * 1{,}000}{VMT_{(UBUS\ \ \boldsymbol{OR}\ \ LDH1)}}$$

Where,
Fuel_Consumption is the total fuel consumption for the vehicle type, in 1,000 gallons per day, from EMFAC 2014, and

VMT is the total vehicle miles traveled for the vehicle type, in miles per day, from EMFAC 2014.

3. Diesel emission factors were developed using data as described in (a) below. Emission factors for other fuel types convert the diesel new service fuel consumption rate to the appropriate fuel type as described in (b).
    a. Diesel: the new service emission factor (**NSEF**, in grams of CO_2e per mile) for each calendar year and model year were obtained by multiplying the new service fuel consumption rate (**NSCR**, in gallons per mile) by the Well-to-Wheels carbon content factor for diesel (13,818.14 g CO_2e per gallon) using the following equation:

$$NSEF = 13{,}818.14 * NSCR$$

    b. Non-Diesel: For fuel types other than diesel, staff converted the diesel fuel consumption rate (**NSCR**) from Step 2 to the equivalent new service emission factor (**NSEF**, in grams of CO_2e per mile) using the following equation:

$$NSEF_{new\_fuel} = NSCR_{diesel} * ED_{diesel} * \left(\frac{1}{ED_{new\_fuel}}\right) * \left(\frac{1}{EER}\right) * CC_{new\_fuel}$$

Where,

$NSCR_{diesel}$ = New Service Consumption Rate for diesel, from Step 2 (gallons per mile)

ED_{diesel} = 134.47 MJ per gallon, from Table E-1

$ED_{new\ fuel}$ = Energy density of the new fuel type (MJ per unit of new fuel), from Table E-1

EER = Energy Economy Ratio (unitless), from Table E-1

CC_{new_fuel} = Carbon Content of the new fuel type (grams of CO_2e per unit of new fuel), from Table E-1

Table E-1. Fuel-Specific Factors

Fuels (units)	Energy Density	Carbon Content gCO_2e/unit*	EER Values Relative to Diesel
Diesel (gal)	134.47 (MJ/gal)	13,818.14 (gCO_2e/gal)	1.0
Gas (gal)	115.63 (MJ/gal)	11,460.09 (gCO_2e/gal)	0.9
CNG (scf)	0.98 (MJ/scf)	77.88 (gCO_2e/scf)	0.9
LNG (gal)	78.83 (MJ/gal)	6,824.31 (gCO_2e/gal)	0.9
Hydrogen (kg)	120.00 (MJ/kg)	12,678.00 (gCO_2e/kg)	1.9
Hydrogen SB 1505 compliant (kg)		10,466.4 (gCO_2e/kg)	
Electric (KWh)	3.6 (MJ/KWh)	378.58 (gCO_2e/KWh)	4.2 (Bus) 2.7 (Shuttle/Van) 4.6 (Heavy Rail) 3.3 (Light Rail)

*Calculated using fuel type megajoule (MJ) per unit of fuel from ARB Staff Report Table III-2. Energy Densities of LCFS Fuels and Blendstocks[41] and ARB CA-GREET fuel type grams of CO_2e per MJ.[42]

[41] Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Proposed Re-Adoption of the Low Carbon Fuel Standard, December 2014

[42] Direct values (without energy efficiency ratio adjustments). Source: California Air Resources Board, CA-GREET 1.8b versus 2.0 CI Comparison Table, April 1, 2015

Train Emission Factors

Train emission factors were derived using the following process.

1. A Train Consumption Rate (TCR, in gallons of diesel per mile) was calculated using the total gallons of diesel fuel used by 130 trains across the State in 2010 divided by the total mileage of those trains using the following equation:

$$TCR_{diesel} = \frac{Fuel\ Consumption}{VMT}$$

2. The diesel emission factor was developed using data as described in (a) below. Emission factors for other fuel types convert the diesel new service fuel consumption rate to the appropriate fuel type as described in (b).
    a. Diesel: the new service emission factor (**NSEF**, in grams of CO_2e per mile) for each calendar year and model year were obtained by multiplying the new service fuel consumption rate (**NSCR**, in gallons per mile) by the Well-to-Wheels carbon content factor for diesel (13,818.14 g CO_2e per gallon) using the following equation:

$$NSEF = 13{,}818.14 * TCR$$

    b. Non-Diesel: For fuel types other than diesel, staff converted the diesel fuel consumption rate (**NSCR**) from Step 2 to the equivalent new service emission factor (**NSEF**, in grams of CO_2e per mile) using the following equation:

$$NSEF_{new\_fuel} = TCR_{diesel} * ED_{diesel} * \left(\frac{1}{ED_{new\_fuel}}\right) * \left(\frac{1}{EER}\right) * CC_{new\_fuel}$$

Where,

$NSCR_{diesel}$ = New Service Consumption Rate for diesel, from Step 2 (gallons per mile)

ED_{diesel} = 134.47 MJ per gallon, from Table E-1

$ED_{new\ fuel}$ = Energy density of the new fuel type (MJ per unit of new fuel), from Table E-1

EER = Energy Economy Ratio (unitless), from Table E-1

CC_{new_fuel} = Carbon Content of the new fuel type (grams of CO_2e per unit of new fuel), from Table E-1

Ferry Emission Factors

Due to the high variability in ferries, standardized emission factors are not available for new/expanded ferry service. Emissions for ferries require project-specific information on the estimated quantity and type of fuel used annually, which are used with the appropriate carbon content factor from Table E-1 to convert fuel to GHG emissions.